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IMAGE ANALYSIS STUDY OF SCREENED SAMPLES FROM LOT NO. 112, ZONE 1, OF ORE FROM NIOBEC, INC.

by

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~~Image analysis~~
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Ores.
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IMAGE ANALYSIS STUDY OF SCREENED SAMPLES FROM LOT NO. 112, ZONE 1, OF ORE FROM NIOBEC, INC.

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ABSTRACT

An image analysis study was conducted on four samples of a "difficult to process" ore from Niobec Mines Incorporated to determine the liberation properties of the pyrochlore. The samples supplied had been screened into 65-100 mesh (208-147 μm), 100-200 mesh (147-74 μm), 200-400 mesh (74-37 μm) and -400 mesh (-37 μm) fractions, and the fractions were separated with a heavy liquid having a specific gravity of 3.3. The weights supplied indicated that the ore had been ground to about 42% minus 200 mesh (-74 μm). Analyses with the scanning electron microscope show that columbite and several compositional varieties of pyrochlore are present, with the relative quantities of pyrochlore: columbite being about 5.5:1. It was determined, by combining the image analysis data for the screened samples, that about 55% of the pyrochlore and 10% of the columbite in the ore had been liberated. The remaining 45% of the pyrochlore is in mixed grains that contain different proportions of pyrochlore, columbite, hematite, carbonates, apatite and silicates. The average mineral content for mixed grains that would likely be recovered in a pyrochlore concentrate is 62 vol. % pyrochlore, 20 vol. % columbite, 13 vol. % hematite, and 5 vol. % carbonates. It is interpreted that regrinding ore streams containing the mixed grains to 80% minus 270 mesh would liberate much of the remaining pyrochlore. This should improve pyrochlore recoveries and concentrate grades.

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ÉTUDE PAR ANALYSE D'IMAGES D'ÉCHANTILLONS DE MINERAI TAMISÉ PROVENANT DU LOT N° 112, DE LA ZONE 1 DE LA NIOBEC INC.

par

William Petruk

RÉSUMÉ

Une étude par analyse d'images a été effectuée sur quatre échantillons d'un minerai difficile à traiter provenant de la Niobec Mines Incorporated, dans le but de déterminer les propriétés de libération du pyrochlore. Les échantillons fournis ont été tamisés en fractions de 208-147 µm (à la maille 65-100), de 147-74 µm (à la maille 100-200), de 74-37 µm (à la maille 200-400) et de -37 µm (à la maille -400); ces fractions ont été séparées avec un liquide lourd d'une densité de 3,3. Les poids fournis indiquaient que le minerai a été broyé à environ 42 % à moins 74 µm (à la maille -200). Les résultats de l'analyse effectuée à l'aide d'un microscope électronique à balayage ont indiqué la présence de columbite et de plusieurs variétés de pyrochlore de composition. Les quantités relatives de pyrochlore: columbite étaient d'environ 5,5:1. En combinant les donnés obtenues des analyses d'images des échantillons tamisés, il a été déterminé qu'environ 55 % du pyrochlore et 10 % de la columbite contenus dans le minerai ont été libérés. Le reste du pyrochlore, soit 45 %, se trouve en grains mélangés contenant différentes teneurs en pyrochlore, columbite, hématite, carbonates, apatite et silicates. La teneur moyenne en minéraux pour des grains mélangés pouvant être récupérés dans un concentré de pyrochlore est de 62 % en vol. de pyrochlore, 20 % en vol. de columbite, 13 % en vol. d'hématite et 5 % en vol. de carbonates. Il résulte de ceci que le rebroyage à 80 % de passant à la maille moins 270 des grains mélangés contenus dans les circuits de minerais permettrait la libération d'une bonne partie du pyrochlore restant. Ce rebroyage devrait augmenter la quantité de pyrochlore récupéré et la teneur des concentrés.

INTRODUCTION

A request to conduct an Image Analysis study on four samples of Niobec ore was received from Mr. R. Biss of Niobec, Les Services TMG Inc., St. Honore, Cte Dubuc, Quebec, G0V 1L0 on September 5, 1985. Mr. Biss stated that the samples were prepared from a difficult to process ore (lot No. 112, Zone I) by screening into 65 to 100 mesh (208-147 μm), 100-200 mesh (147-74 μm), 200-400 mesh (74-37 μm), and minus 400 mesh (-37 μm) fractions, and separating each fraction in a heavy liquid having a specific gravity of 3.33. The heavy liquid concentrates were received for study.

Mr. Biss requested the following information on each sample:

(1) the nature of pyrochlores;
(2) proportions of pyrochlore and columbite and their modes of occurrence;
(3) proportion of pyrochlore, columbite and hematite in mixed grains;
(4) proportions of silicates, pyrochlore and columbite in mixed grains;
(5) proportions of carbonates, apatite, pyrochlore and columbite in mixed grains;
(6) mode of occurrence of tantalum;
(7) determination of presence of magnetite.

The samples were studied with the SEM-IPS image analysis system by identifying the minerals with the energy dispersive X-ray analyser, and by determining mineral quantities, degrees of liberation, and size distributions with the image analyser.

Mineralogy of Samples

The minerals found in the samples are hematite, pyrochlore, columbite, pyrite, calcite, dolomite, quartz, an Fe, Mg, Ti, Al silicate (assumed to be either amphibole or pyroxene or both), apatite, zircon, barite, a Ce-Ca-Fe-bearing rare earth mineral, and a silicate that contains small to significant amounts of Ba, Ca, Fe, Y, Na, Mg. Several varieties of pyrochlore are present; they had been classified as Na pyrochlore, Ti pyrochlore, Fe pyrochlore and a Sr + Y pyrochlore by Petruk (1985) and the classification will be retained in this report. The mineral compositions were not determined during this study, since the minerals had been analysed by quantitative EDXA by Petruk (1985). However, the presence of Na, Ti, Fe, Sr and Y was confirmed. The mineral quantities in the samples were determined with the SEM-IPS image analysis system by measuring the surface areas covered by each mineral in polished sections and using the specific gravities reported in Table 1 to calculate the weight per cent of each mineral (Table 1). The data for the four screened fractions were combined using the wt. % of each fraction.

Assays for the samples were provided by Mr. Biss and are included in Table 2. A comparison was made between the assay values and the calculated elemental contents. The elemental contents were calculated by using the mineral contents reported in Table 1 and assuming the following: Na and Ti pyrochlore contain 65 wt. % Nb_2O_5, 15 wt. % CaO and 0.9 wt. % Fe; Fe and Sr

Table 1. Mineral quantities* in samples

Mineral	Specific gravity	Sample				
		-400 mesh (-37 μm) wt %	400-200 mesh (37-74 μm) wt %	200-100 mesh (74-147 μm) wt %	100-65 mesh (147-208 μm) wt %	combined
Na pyrochlore	4.5	8.0	8.1	10.4	10.7	9.4
Ti pyrochlore	5.0	8.0	5.9	5.5	6.0	6.0
Fe & Sr pyrochlore**	5.5	23.3	17.0	15.7	17.0	17.0
Columbite	5.2	8.1	5.5	6.1	3.6	5.9
Hematite	5.2	38.4	45.2	45.8	39.5	44.2
Quartz	2.7	1.1	0.8	0.4	0.3	0.6
"Amphibole"***	3.0	0.8	1.1	1.8	1.9	1.5
Dolomite	2.8	0.5	0.8	0.8	2.2	0.9
Calcite	2.7	2.9	3.5	6.4	7.6	5.3
Apatite	3.1	0.9	2.5	2.9	5.7	2.9
Pyrite	5.0	6.9	9.1	4.1	4.3	6.0
Barite****	4.5	0.2	0.1	0.1	0.1	0.1
Zircon	4.6	0.8	0.4	-	0.8	0.3
Total		100.0	100.0	100.0	100.0	100.0
Pyrochlore/columbite		4.83	5.63	5.18	9.46	5.53

*Mineral quantities determined by measuring surface areas covered by each mineral with image analysis system and calculating wt % using specific gravities.

**The Fe and Sr + Y pyrochlore have the same average atomic number and hence have the same grey level in the BSE image. They were therefore analysed together. Most of the grains were the Fe variety.

***The mineral is a multi-element silicate and is assumed to be an amphibole. A trace amount of a multi-element Ba- and Y-bearing silicate is included.

****Value includes Ce-bearing rare earth minerals.

Table 2. Comparison of assayed and calculated elemental contents

Sample	wt % of sample	Nb_2O_5		SiO_2		CaO		P_2O_5		Fe Total		S	
		assay	calc.	assay	calc.	assay	calc.	assay	calc.	assay	calc.	assay	calc.
65-100 mesh	10.61	17.77	25.1	3.64	1.6	8.00	13.4	1.24	2.5	30.68	30.2	2.20	2.4
100-200 mesh	47.50	19.42	25.3	2.97	1.3	7.03	10.4	0.35	1.3	31.73	34.7	1.80	2.2
200-400 mesh	32.03	15.96	24.6	2.04	1.5	6.04	8.4	0.24	1.1	37.85	36.5	1.40	4.9
-400 mesh	9.86	20.94	32.0	1.96	1.8	7.36	8.4	-	0.4	31.32	31.2	1.50	3.7
overall	100.00	18.29	25.7	2.64	1.4	6.85	9.9	0.38	1.3	33.54	34.5	1.68	3.2

pyrochlores contain 68 wt. % Nb_2O_5, 15 wt. % CaO, and 2 wt. % Fe; columbite contains 71 wt. % Nb_2O_5, 1.7 wt. % CaO and 12 wt. % Fe (Petruk, 1985); stoichiometric compositions for the other minerals. A comparison of the assayed and calculated values shows that the calculated values for Nb_2O_5, CaO, S and P_2O_5 are higher than the assay values, the amounts of SiO_2 are lower, and calculated total Fe values are about the same as the assay values. This suggests that during sample preparation the pyrochlore, columbite, pyrite and apatite were concentrated at the surfaces of the polished sections, the silicates were depleted, and the hematite was representative for the sample.

MODES OF OCCURRENCE AND RELATIONSHIPS OF MINERALS

Pyrochlore

Several varieties of pyrochlore are present and they have been classified as Na, Ti, Fe, and Sr + Y pyrochlores. The pyrochlore varieties occur as separate grains, as intergrowths with other pyrochlore varieties, as intergrowths with columbite, and as intergrowths with other minerals. Image analysis studies were conducted on total pyrochlore, Na pyrochlore, Ti pyrochlore, and combined Fe pyrochlore plus Sr + Y pyrochlore. The quantities of the pyrochlore varieties and the relative quantities of pyrochlore to columbite in the samples are included in Table 1.

Total pyrochlore

Data from liberation studies show that 59.1, 51.2, 48.9 and 35.3% of the total pyrochlore in the 65-100 mesh (208-147 μm), 100-200 mesh (147-74 μm), 200-400 mesh (74-37 μm, and -400 mesh (-37 μm) samples respectively occurs in particles that contain more than 90% by area pyrochlore and less than 10% by area of other minerals including columbite (Table 3). The calculated value by combining the samples is 54.8%. The remainder of the pyrochlore occurs in particles that contain from 1 to 90% by area of pyrochlore. The particles have been classified as containing 0-10, 10-20, ...80-90%, etc. pyrochlore by area % (Fig. 1 and Tables 4a, 4b and 4c). Most of the pyrochlore inclusions in the particles range from 13 to greater than 147 μm in diameter, with the large inclusion being in the two coarse-grained fractions. This suggests that grinding to -400 mesh would liberate all the pyrochlore in the 65-100 mesh (208-147 μm) and 100-200 mesh (147-74 μm) samples, but would not liberate much of the unliberated pyrochlore that is in the two finer-grained fractions.

Na pyrochlore

The Na pyrochlore is generally intergrown with other pyrochlore varieties and with columbite. Data on liberation studies show that 24.1, 26.5, 8.2 and 4.4% of the Na pyrochlore in the 65-100 mesh (208-147 μm), 100-200 mesh (147-74 μm), 200-400 mesh (74-37 μm) and -400 (-37 μm) samples respectively occurs in grains that contain more than 90% by area Na pyrochlore and less than 10% by area other pyrochlore varieties plus columbite (Table 3, Fig. 2, Tables 5a, 5b and 5c). The remainder of the Na

Table 3. Liberation characteristics of minerals

Mineral	Liberation	Mode	-400M	400-200M	200-100M	65-100M	Combined
			%	%	%	%	
Pyrochlore	free	+90% free from all minerals	35	49	51	59	55
Na pyrochlore	free	+90% free from columb. + pyro.	4	8	26	24	23
Ti porochlore	free	+90% free from columb. + pyro.	0	0	1	-	-
Fe plus Sr+Y pyro.	free	+90% free from columb. + pyro.	38	37	47	46	46
Columbite	free	+90% free from all minerals	7	7	12	23	10
Columbite	free	+90% free from pyrochlore	8	13	40	26	28
Hematite	free	+90% free from all minerals	27	39	36	30	33
Hematite	locked	locked in pyrochlore and columb.	10	14	10	11	13
Hematite	locked	>90% hematite, <10% pyro. + columb.	5	7	7	5	7
Hematite	locked	<90% hematite, >10% pyro. + columb.	5	7	3	6	6
Hematite	locked	with silicates, carb. etc.	63	47	54	59	54
Carbonates	locked	in pyrochlore plus columbite	15	16	22	26	21
Carbonates	locked	>90% carbonates, <10% pyro. + columb.	8	4	2	6	5
Carbonates	locked	<90% carbonates, >10% pyro. + columb.	7	12	20	20	16
Apatite	locked	>90% apatite, <10% pyro. + columb.	13	19	35	23	27
Apatite	locked	<90% apatite, >10% pyro. + columb.	0	0	0	0	0
Silicates	locked	>90% silicates, <10% pyro. + columb.	1	5	12	10	10

pyrochlore in the 65-100 mesh (208-147 μm) and 100-200 mesh (147-74 μm) samples occurs in particles that contain more than 40% by area Na pyrochlore, whereas in the 200-400 mesh (74-37 μm) and -400 mesh (-37 μm) samples the mineral occurs in particles that contain 10-90% by area Na pyrochlore (Fig. 2, Tables 5a to 5c). The size of the Na pyrochlore inclusions varies from 6.5 to greater than 147 m with the large inclusions being prevalent in the coarse-grained fraction, and relatively small inclusions in the fine-grained fractions. These data show that most of the unliberated Na pyrochlore in the two-coarser-grained fraction is relatively coarse-grained, whereas the unliberated Na-pyrochlore in the two finer-grained fractions is very fine-grained.

Ti pyrochlore

The Ti pyrochlore in all samples occurs in pyrochlore-columbite particles that contain up to 80% Ti pyrochlore with the most common ones containing 30 to 50% Ti pyrochlore (Fig. 3, Table 6a to 6c). Most of the Ti pyrochlore inclusions in the pyrochlore-columbite grains are larger than 37 μm in the 65-100 mesh (208-147 μm) sample, larger than 26 μm in the 100-200 mesh (147-74 μm) sample, larger than 9 μm in the 200-400 mesh (74-37 μm) sample, and larger than 6.5 μm in the -400 mesh (-37 μm sample). The intimate intergrowth of Ti pyrochlore with other pyrochlore varieties suggests that extremely fine grinding would be required to liberate the Ti pyrochlore from other pyrochlore varieties. The absence of free Ti pyrochlore in the samples confirms this.

Fe plus Sr pyrochlore

The Fe pyrochlore and the Sr + Y bearing pyrochlores are the most common varieties of pyrochlore. Many grains are intergrown with other varieties of pyrochlore, many occur as separate grains, and some are intergrown with columbite and other minerals. Liberation studies show that 46.0, 47.1, 36.9 and 37.8% of the Fe and Sr + Y pyrochlore in the 65-100 mesh (208-147 μm), 100-200 mesh (147-74 μm) 200-400 mesh (74-37 μm), and -400 mesh (-37 μm) samples respectively occur in grains that contain more than 90% by area of Fe and Sr + Y pyrochlore and less than 10% other pyrochlore varieties plus columbite. The remaining Fe and/or Sr + Y pyrochlore occurs in grains that contain from 90% to less than 10% Fe and/or Sr + Y pyrochlores. The sizes of the Fe and/or Sr + Y pyrochlore inclusions (Fig. 4, Tables 7a-7c) are greater than 26, 12.5, 9, and 6.5 μm in the respective sized samples.

Columbite

Most of the columbite in the samples studied is intergrown with pyrochlore. Liberation studies show that 6.5, 7.1, 11.8 and 23.1% of the columbite in the respective sized fractions, from the coarsest to the finest, occurs in grains that contain more than 90% columbite and less than 10% other minerals. When only the columbite-pyrochlore mineral pair is considered the percentages of columbite in grains containing more than 90% columbite and less than 10% pyrochlore in the above samples are 8.2, 12.8, 40.2 and 25.8 respectively (Table 3). The proportion of totally free columbite was not

measured. The remaining columbite in all minerals (Fig. 5, Tables 8a-8c) and in pyrochlore respectively (Fig. 6, Tables 9a-9c) occurs in grains that contain from 90% to less than 10% columbite. The sizes of the columbite inclusions range from 3.3 to 147 micrometres with the large inclusions being in the coarse-grained fractions and the small inclusions in the fine-grained fractions. The sequences of percentages of liberated columbite in the sized fractions indicate that the columbite is fine grained. It is interpreted that the minimum grind for columbite liberation is about 80% minus 270 mesh.

Hematite

The hematite content in the samples varies from 38 to 46 wt. % (Table 1). The percentage of hematite in the sample that occurs in grains which contain more than 90% hematite and less than 10% other minerals is 30.3, 36.0, 38.9 and 27 in 65-100 mesh (208-147 μm), 100-200 mesh (147-74 μm), 200-400 mesh (74-37 μm) and -400 mesh (-37 μm) samples respectively (Fig. 7, Tables 3, 10a-10c). The remainder of the hematite is in particles that contain various amounts of hematite. The sizes of the hematite inclusions in the hematite-bearing particles varies from 13 to greater than 147 μm with the small sized inclusions being in particles in the fine-grained fractions. The proportion of hematite that occurs in mixed grains of hematite combined with silicates, carbonates plus apatite varies from about 47 to 63% (Table 3).

About 9.8 to 13.6% of the hematite in the samples is combined with pyrochlore plus columbite with about 1/3 to 1/2 of this combined hematite being in grains that contain more than 90% hematite and less than 10% pyrochlore plus columbite. The rest of this combined hematite is in grains that contain various amounts of mixed grains hematite and pyrochlore plus columbite. The proportion of hematite/pyrochlore + columbite varies from 0 to 99%, with most being in the 70-90°C category (Fig. 8). The hematite inclusions in pyrochlore are much finer grained than the hematite inclusions in other minerals (Fig. 5, 7 & 8, Tables 10a-10c and 11a-11c).

Carbonates

The main carbonate in the samples is calcite but some dolomite is also present (Table 1). Both carbonates were analysed together for the liberation studies. It was determined that only a small proportion of the carbonates is associated with pyrochlore plus columbite, ranging from about 15% of the carbonates in the -400 mesh (-37 μm) sample to 26% of the carbonates in the 65-100 mesh (208-147 μm) sample (Table 3). In the -400 mesh (-37 μm) and the 200-400 mesh (74-37 μm) samples, 52% and 27% respectively of the carbonates associated with pyrochlore plus columbite occur in particles that contain more than 90% carbonates and less than 10% pyrochlore plus columbite (Fig. 9, Tables 12a-12c). Most of the remaining carbonates occur in particles that contain less than 50% carbonates and more than 50% pyrochlore plus columbite. The carbonate inclusions in the pyrochlore plus columbite particles in these two samples range from about 2 to 26 μm in diameter.

In the 65-100 mesh (208-147 μm) and 100 to 200 mesh (147-74 μm) samples about 23 and 9% respectively (Table 17a) of the carbonates associated with pyrochlore plus columbite are in particles that contain more than 90% carbonate and less than 10% pyrochlore plus columbite. The remainder of the associated carbonate is in particles that contain from 90% to less than 10% carbonates and from 10% to more than 90% pyrochlore plus columbite. The size of the carbonate inclusions in the pyrochlore plus columbite particles in these two samples range from about 9 μm to greater than 147 μm in diameter (Fig. 9, Tables 12a-12c).

Apatite

The quantities of apatite in the samples are given in Table 1. A comparison of these quantities with the chemical assays (Table 2) shows that more apatite was observed in the polished sections than the chemical assays would permit. This indicates that a higher proportion of apatite was exposed on the polished surface than is representative for the sample.

Liberation studies show that 22.6%, 36.7%, 18.8, and 13.4% of the apatite in 65-100 mesh (208-147 μm), 100-200 mesh (147-74 μm), 200-400 mesh (74-37 μm) and -37 μm samples respectively is associated with pyrochlore plus columbite, but all of this apatite occurs in particles that contain more than 90% apatite and less than 10% pyrochlore plus columbite (Fig. 10, Tables 13a-13c). The size of the apatite inclusions increases progressively from 13 μm in the -400 mesh (-37 μm) sample to larger the 147 μm in the 65-100 mesh (208-147 μm) sample.

Silicates

The silicates in the samples are quartz and other silicates that are assumed to be mainly amphiboles and pyroxenes. A comparison of the calculated and assayed values shows that less silicates were observed in the polished sections than the assay value indicate. Obviously less than a representative amount of silicates was exposed on the surfaces of the polished sections.

Liberation studies show that around 90% of the silicates are in particles that contain more than 90% silicates and less than 10% pyrochlore plus columbite. About 10% of the silicates is in particles that contain small amounts of silicates (Fig. 11. It is interpreted that the silicate in the latter type of particles would not be removed from the pyrochlore and columbite (Fig. 11, Tables 14a and 14c) during mineral beneficiation.

DISCUSSION AND CONCLUSIONS

The combined data for all samples indicate that for the 3.33 sink fraction of the ore, ground to about 42% -200 mesh (-74 μm) (Table 2), 55% of the pyrochlore and 10% of the columbite are present as essentially free grains (grains that contain more than 90% pyrochlore, and more than 90% columbite respectively). These essentially free grains range from smaller

than 37 to 208 μm in diameter. The proportion of essentially free pyrochlore in the sized samples decreases with decreasing size of particles in the samples, whereas the proportion of essentially free columbite increases with decreasing particle size. This indicates that, in the unground ore, most of the pyrochlore is coarse grained, probably in the +100 mesh (+147 μm) size range, and that most of the columbite is fine grained. The size distribution of the columbite inclusions, shown for the combined data (Fig. 5, Table 8c), is likely close to the size distribution for the columbite in the unground ore; i.e. most of the grains are between 6.5 and 104 μm in diameter with 30% being between 37 and 52 μm. It is interpreted from this size distribution data that, to liberate 50% of the columbite (minimum grind for columbite liberation), the ore must be ground to 80% minus 270 mesh (52 μm).

The free pyrochlore consists of (1) Fe pyrochlore that is assumed to contain about 2 wt. % Fe, (2) Sr+Y pyrochlore that is assumed to contain about 2 wt. % Fe, (3) Na pyrochlore that contains about 0.9 wt. % Fe, and (4) a mixture of the above three pyrochlore varieties plus a Ti pyrochlore that is assumed to contain about 0.9 wt. % Fe. Therefore, the Fe content of free pyrochlore is probably between 1 and 2 wt. %.

The unliberated pyrochlore occurs in particles that are composed of one or more pyrochlore varieties intergrown with columbite, hematite, carbonates apatite and silicates. About 45% of the pyrochlore in the ore is unliberated and occurs in particles that contain less than 90% pyrochlore. It was calculated, using Table 3, that the mean mineral content for the pyrochlore-bearing particles is 52.3 vol. % pyrochlore, 19.0 vol. % columbite, 20.4 vol. % hematite, 4.7 vol. % carbonate, 2.9 vol. % apatite and 0.7 vol. % silicates. However, in these pyrochlore-bearing particles all of the apatite, 90% of the silicate, 47.5% of the hematite, and 20.5% of the carbonates are in particles that contain more than 90% of the respective mineral and less than 10% pyrochlore plus columbite. It is expected that during mineral dressing these particles would be rejected to the tailing. These particles which consist essentially of minerals other than pyrochlore, contain about 1.1 wt. % of the pyrochlore and 11.6% of the columbite in the ore (see Tables 4-7 and for amounts of pyrochlore and columbite in 0-10% particles), hence these amounts of pyrochlore and columbite would also be rejected. The mean mineral content of particles containing the remaining pyrochlore (44% of pyrochlore in ore) would be about 62 vol. % pyrochlore, 20 vol. % columbite, 13 vol. % hematite, 5 vol. % carbonates and a trace of silicates.

It is expected that under normal mineral beneficiation conditions the following proportions of pyrochlore might be recovered: 95% of pyrochlore in essentially free grains, 90% of pyrochlore in particles that contain 80-90% pyrochlore, and 70% of pyrochlore in particles that contain 30-80% pyrochlore. It is also expected that most of the particles containing less than 30% pyrochlore would be lost to the tailings. Table 4c shows that 54.8% of the pyrochlore is essentially free, 11.3 is in 80-90% particles, 27.4% in 30-80% particles and 6.5% in 0-30% particles. The predicted maximum recovery of pyrochlore, under normal operating conditions, is 81.4%. Table 4c also shows, however, that 25.2% of the pyrochlore in the ore occurs as

inclusions, larger than 26 μm, in 30 to 80% particles. Regrinding the 30-80% particles would liberate many of the large inclusions and raise the expected recovery of the 30-80% particles to a 90% recovery category. Regrinding streams containing the mixed particles would therefore increase liberation, and would have the effect of increasing the recovery to 84.9%. The increased liberation would also increase the possibility of rejecting the columbite and hematite from the pyrochlore concentrate.

References

1. W. Petruk (1985): "Image analysis and mineralogical studies of a rougher concentrate and a cleaner tailing from Niobec Mines Limited", CANMET, Mineral Sciences Laboratories, Division Report 85-25(CR) - Confidential.

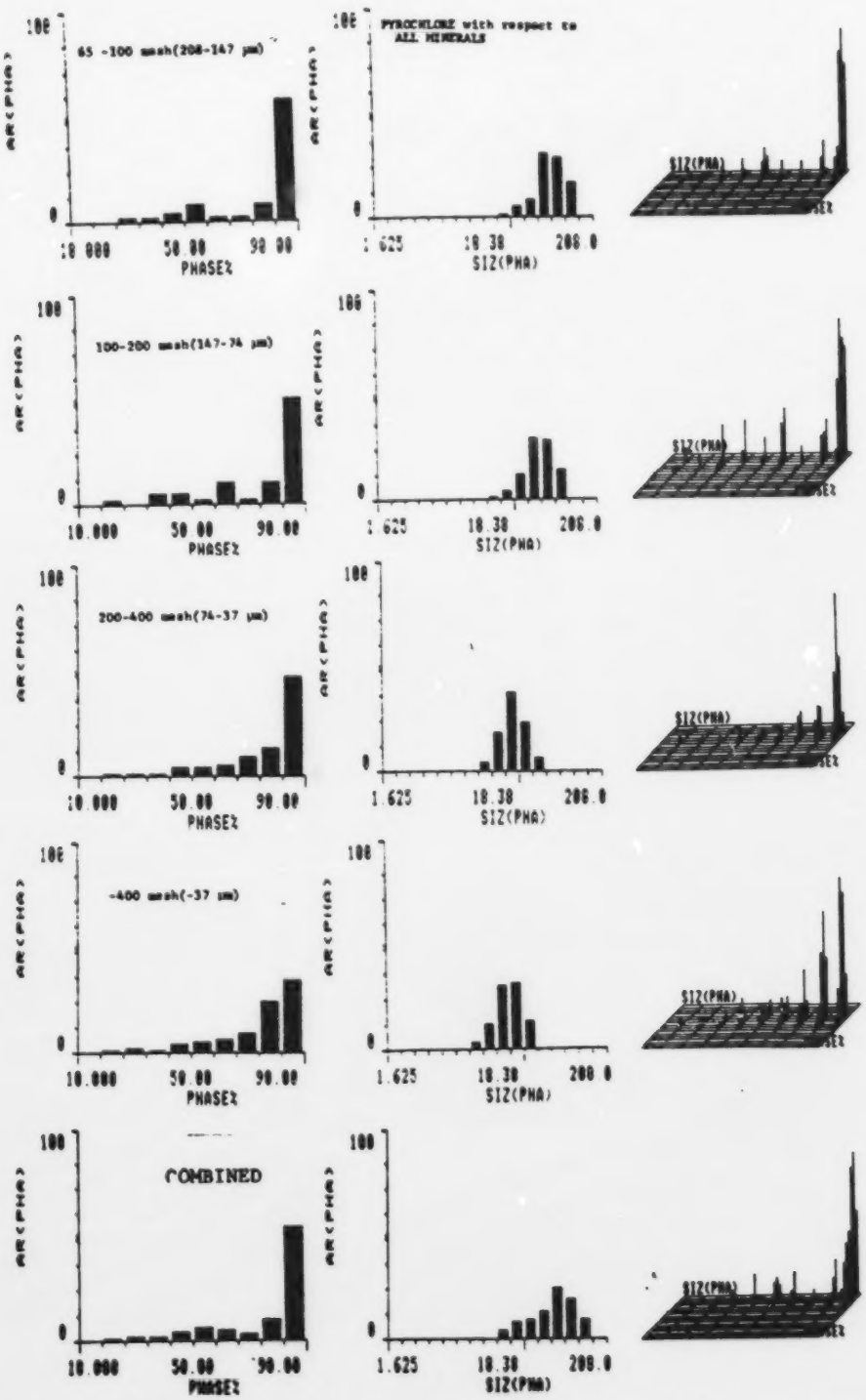

Fig. 1: Histograms giving classification of pyrochlore with respect to all minerals and size distributions of free pyrochlore plus pyrochlore inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for pyrochlore grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free pyrochlore grains as seen in polished sections.

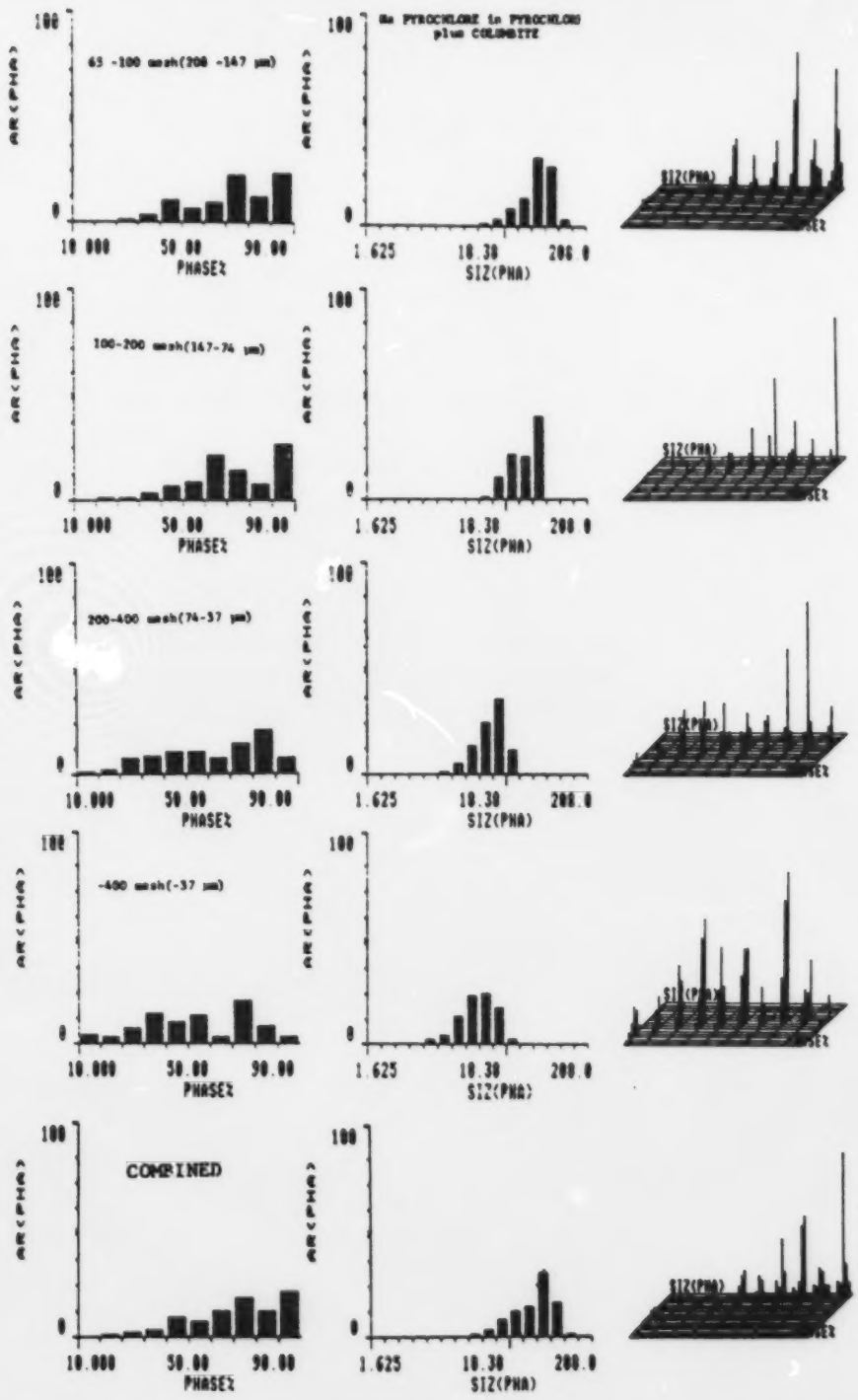

Fig. 2: Histograms giving classification of Na pyrochlore with respect to pyrochlore plus columbite, and size distributions of free Na pyrochlore and Na pyrochlore inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for Na pyrochlore grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free Na pyrochlore grains as seen in polished sections.

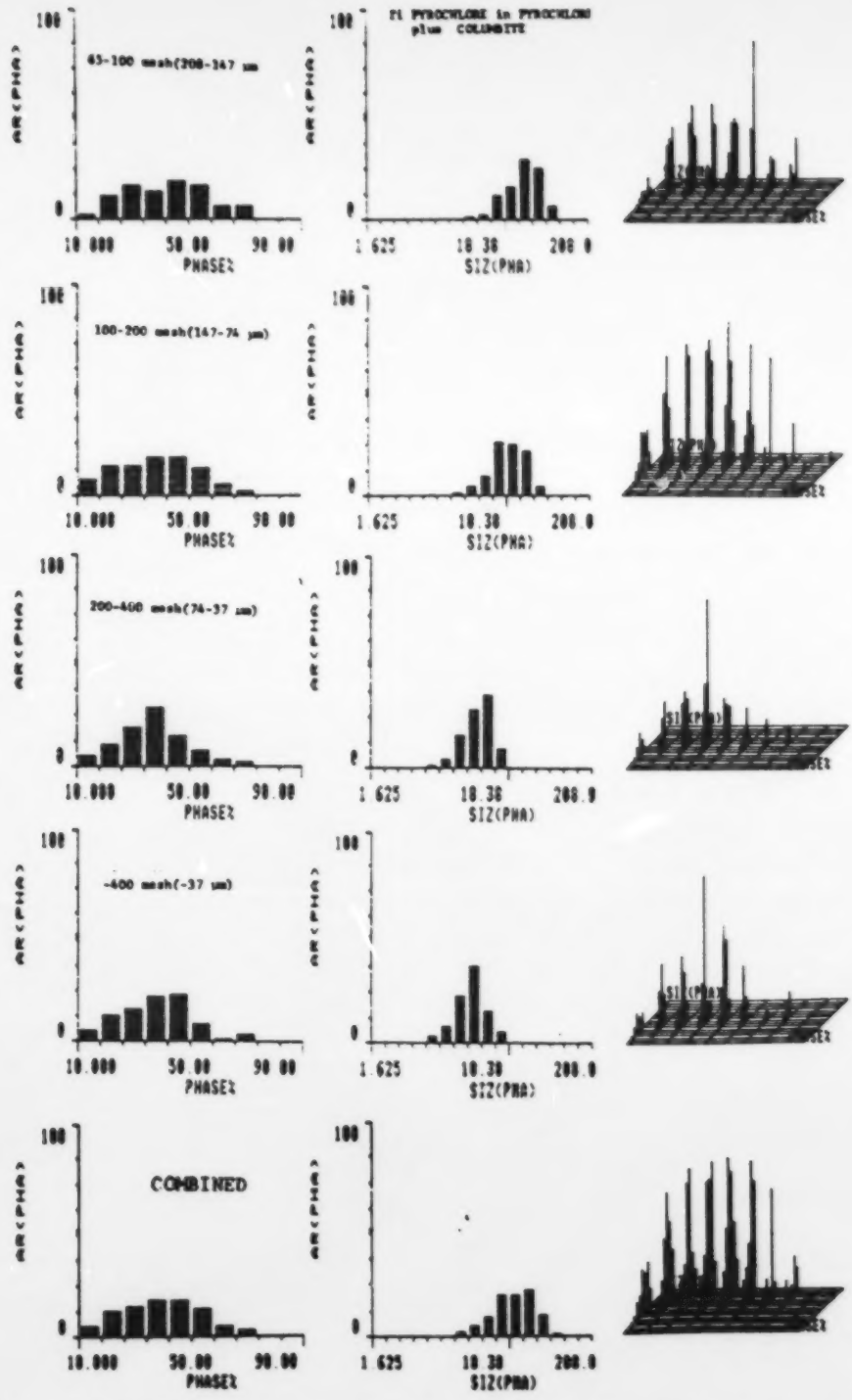

Fig. 3: Histograms giving classification of Ti pyrochlore with respect to pyrochlore plus columbite, and size distributions of free Ti pyrochlore plus Ti pyrochlore inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for Ti pyrochlore grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free Ti pyrochlore grains as seen in polished sections.

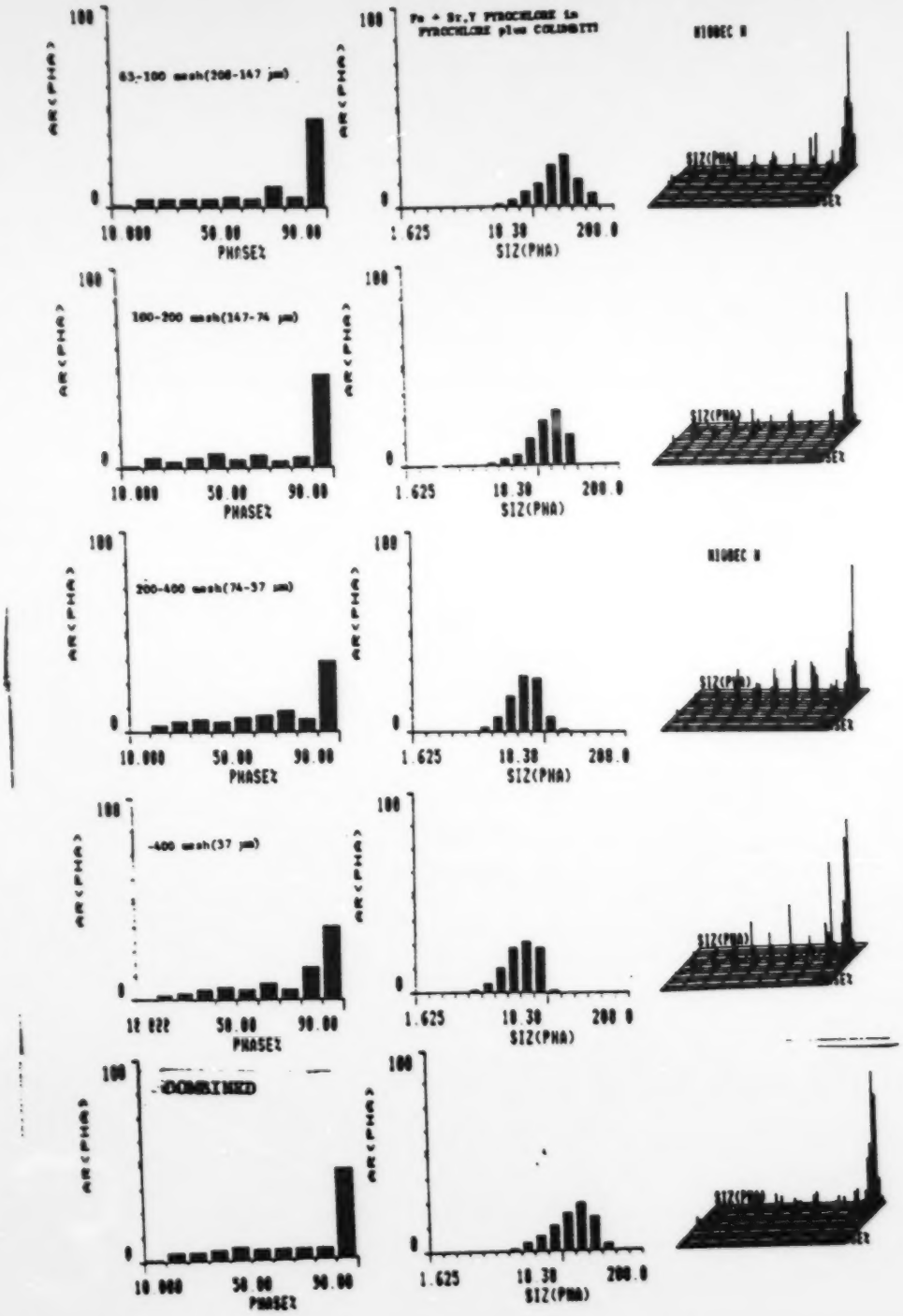

Fig. 4: Histograms giving classification of Fe plus Sr + Y pyrochlore with respect to pyrochlore plus columbite and size distributions of free Fe plus Sr + Y pyrochlore plus Fe plus Sr + Y pyrochlore inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for Fe plus Sr + Y pyrochlore grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free Fe plus Sr + Y pyrochlore grains as seen in polished sections.

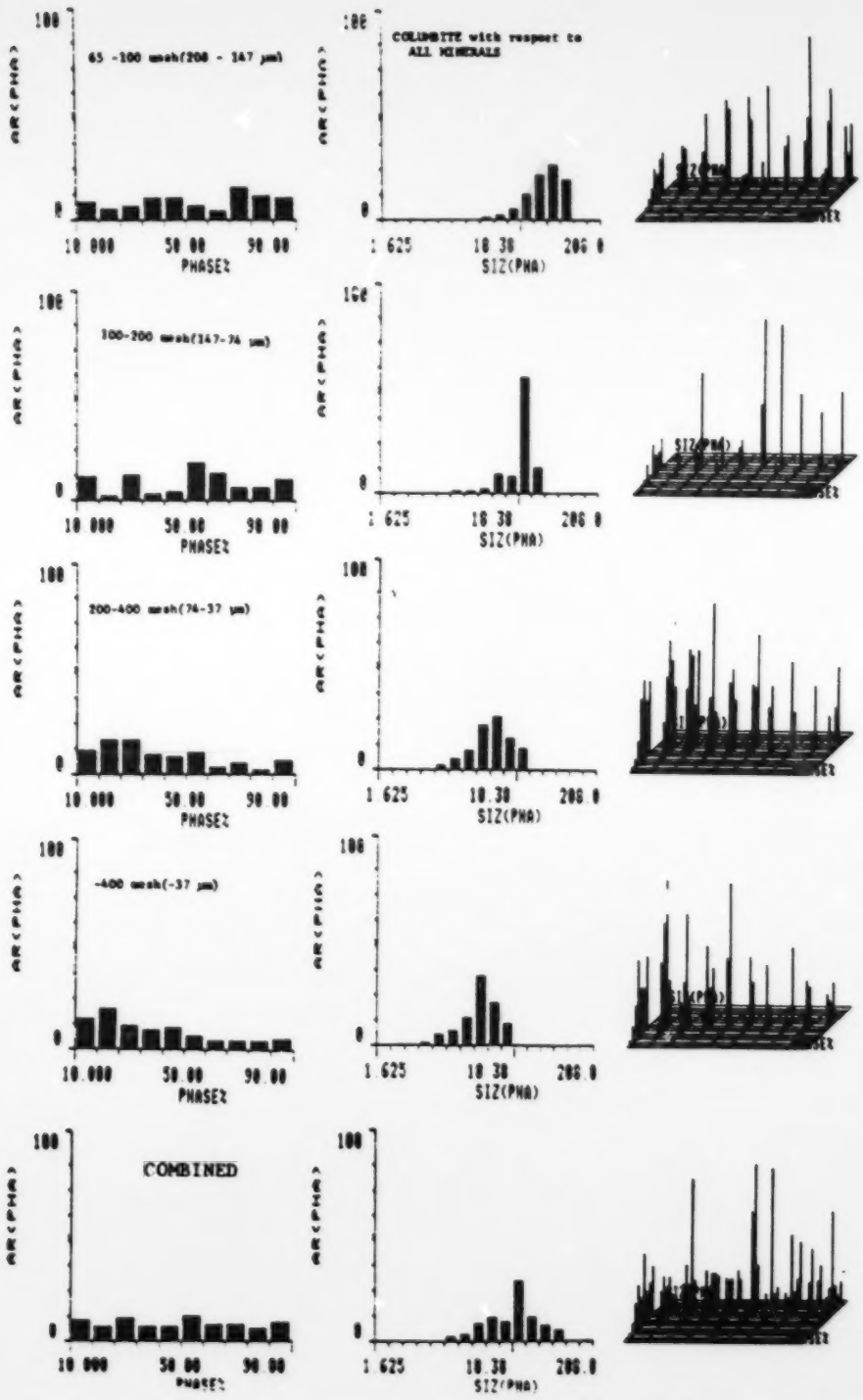

Fig. 5: Histograms giving classification of columbite with respect to all minerals and size distributions of free columbite plus columbite inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for columbite grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free columbite grains as seen in polished sections.

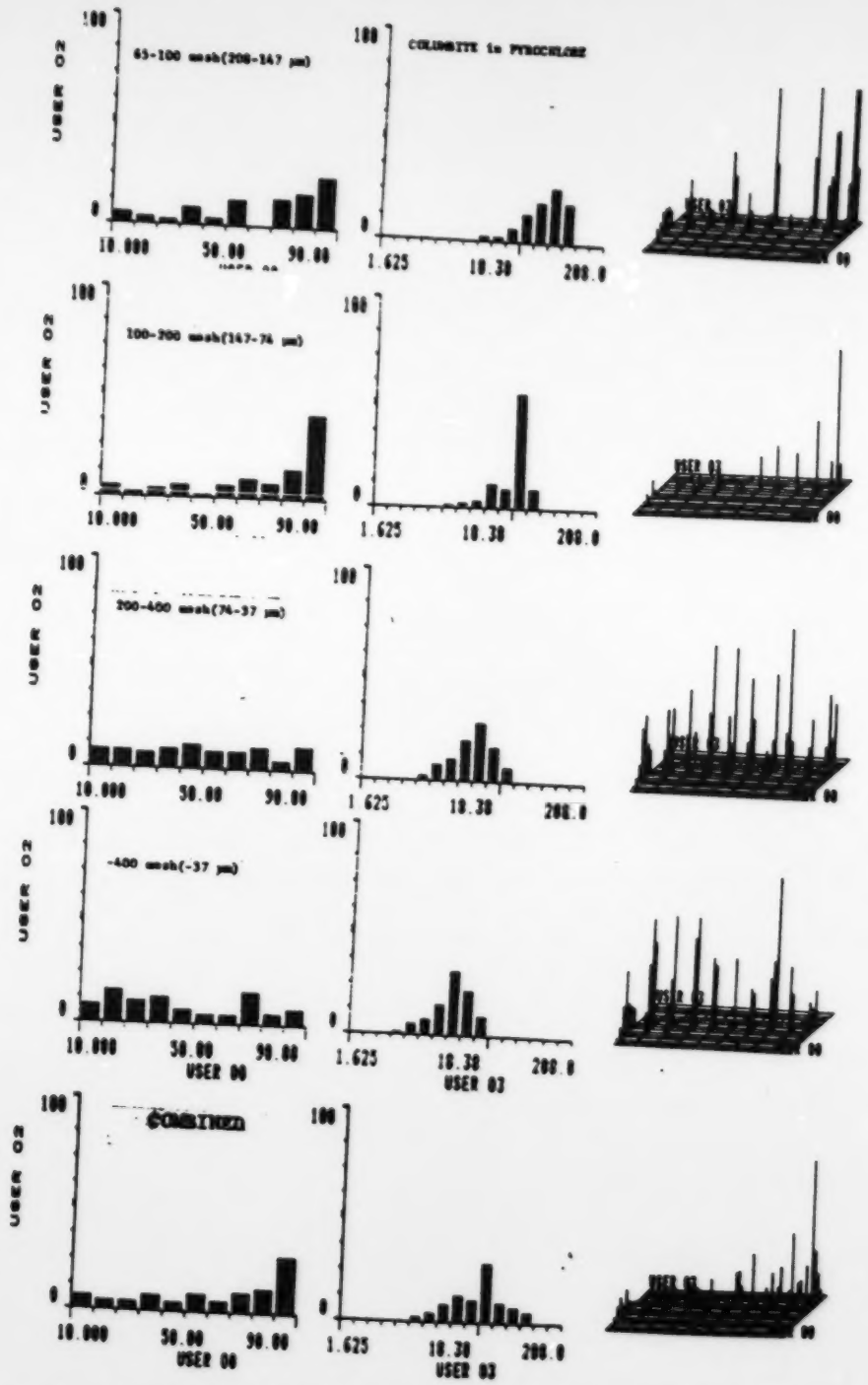

Fig. 6: Histograms giving classification of columbite with respect to pyrochlore and size distributions of free columbite plus columbite inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for columbite grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free columbite grains as seen in polished sections.

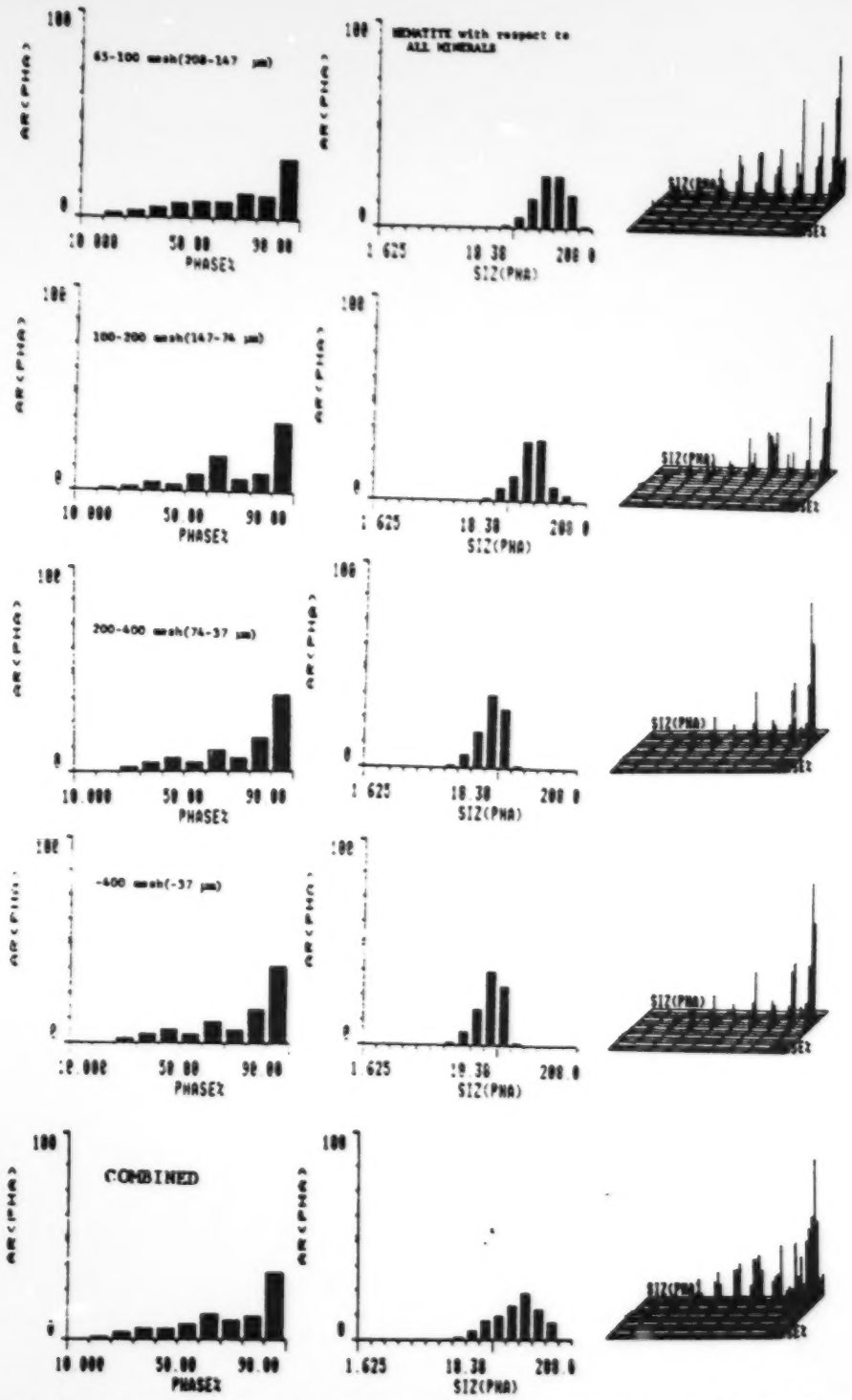

Fig. 7: Histograms giving classification of hematite with respect to all minerals and size distributions of free hematite plus hematite inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for hematite grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free hematite grains as seen in polished sections.

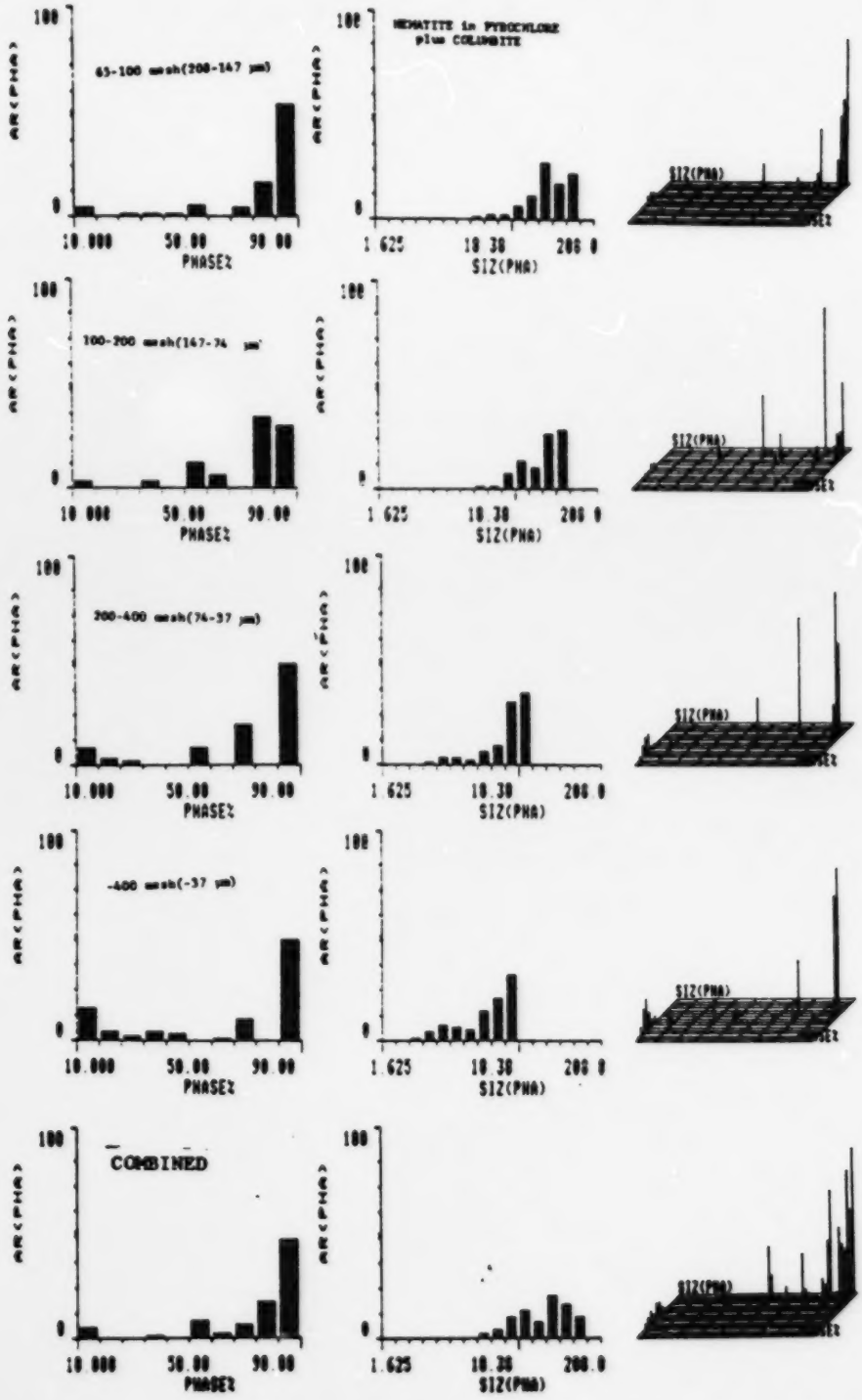

Fig. 8: Histograms giving classification of hematite with respect to pyrochlore plus columbite and size distributions of free hematite inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for hematite grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free hematite grains as seen in polished sections.

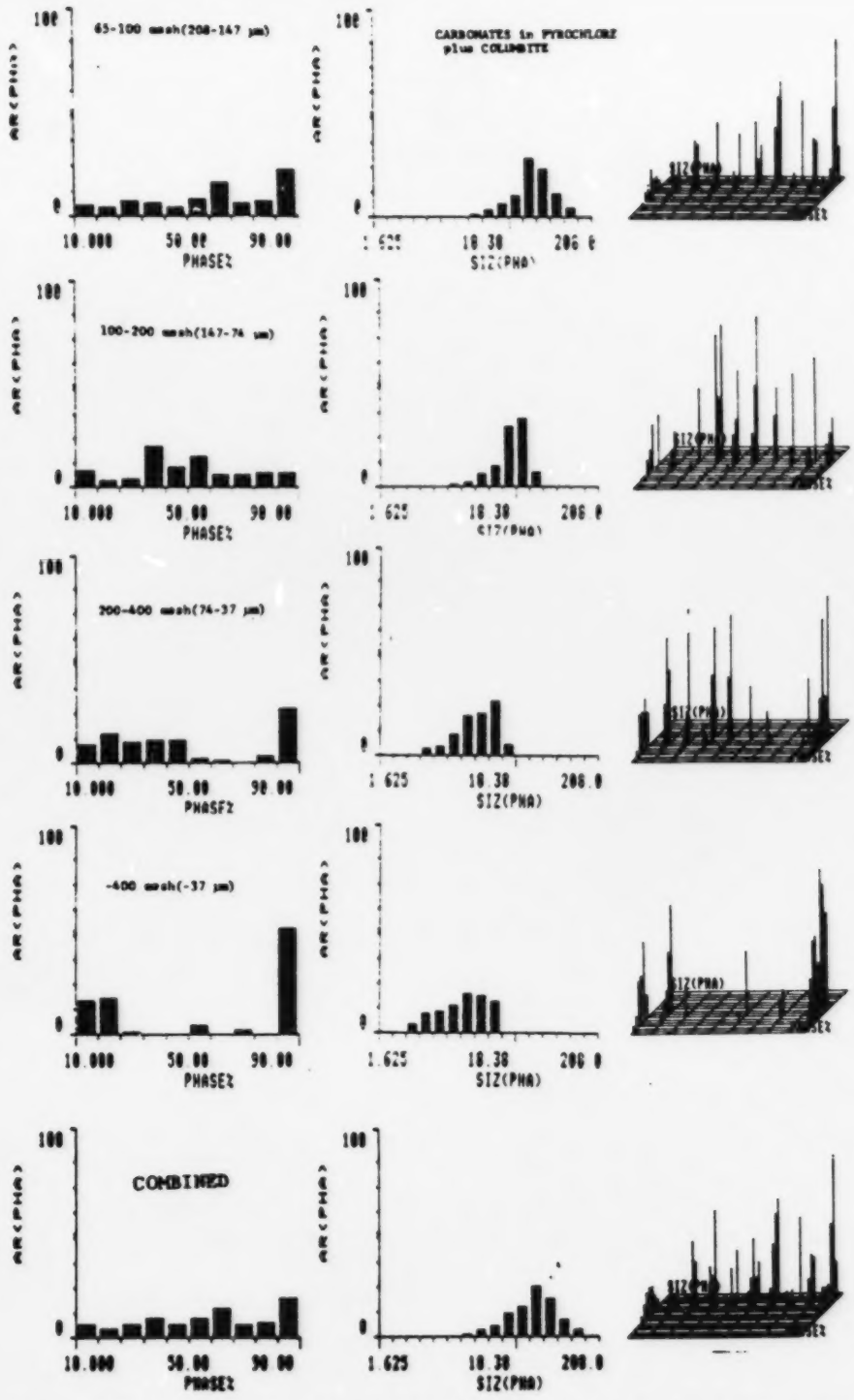

Fig. 9: Histograms giving classification of carbonates with respect to pyrochlore plus columbite and size distributions of carbonate minerals inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for carbonate minerals grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free carbonate minerals grains as seen in polished sections.

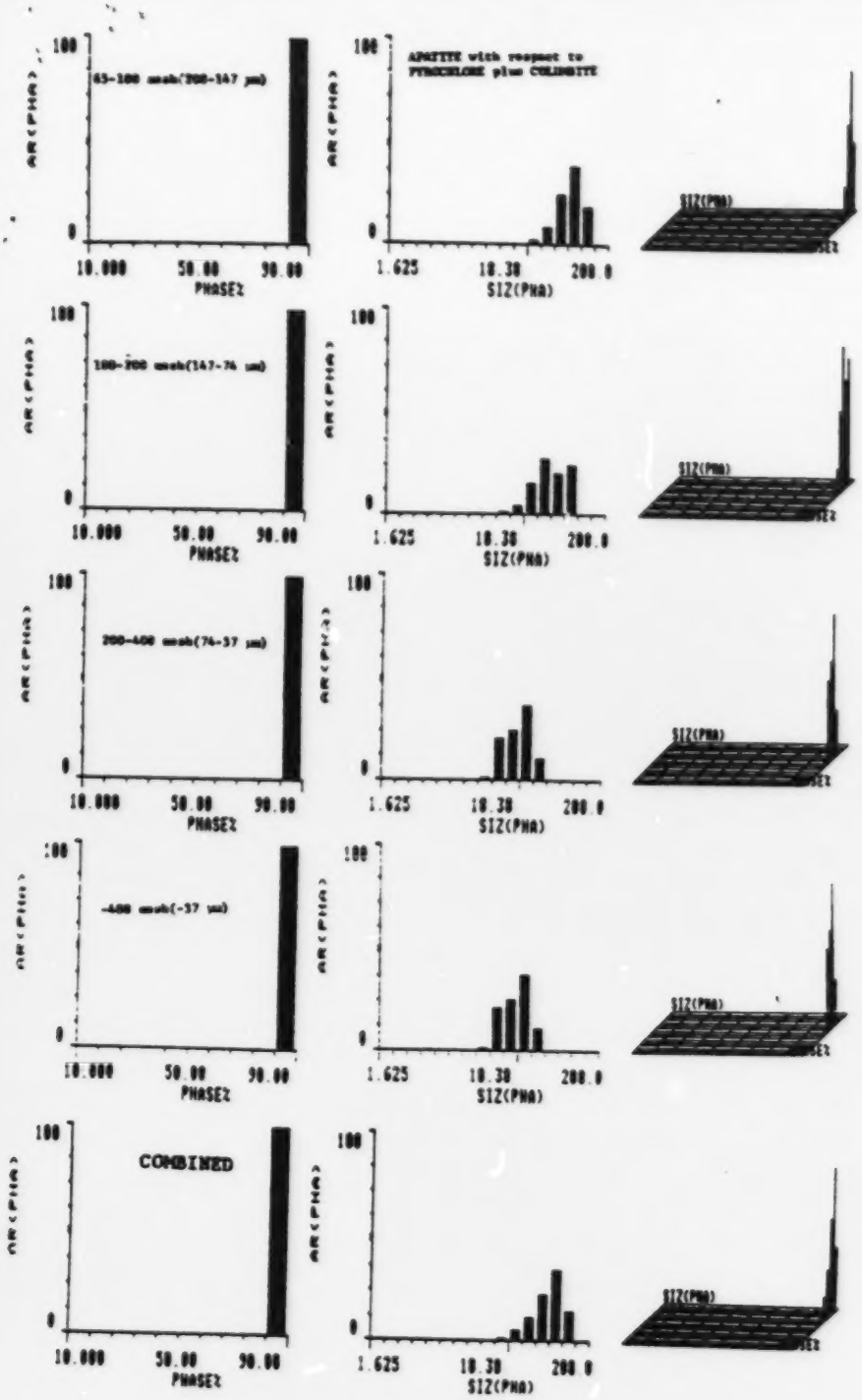

Fig. 10: Histograms giving classification of apatite with respect to pyrochlore plus columbite and size distributions of apatite inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for apatite grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free apatite grains as seen in polished sections.

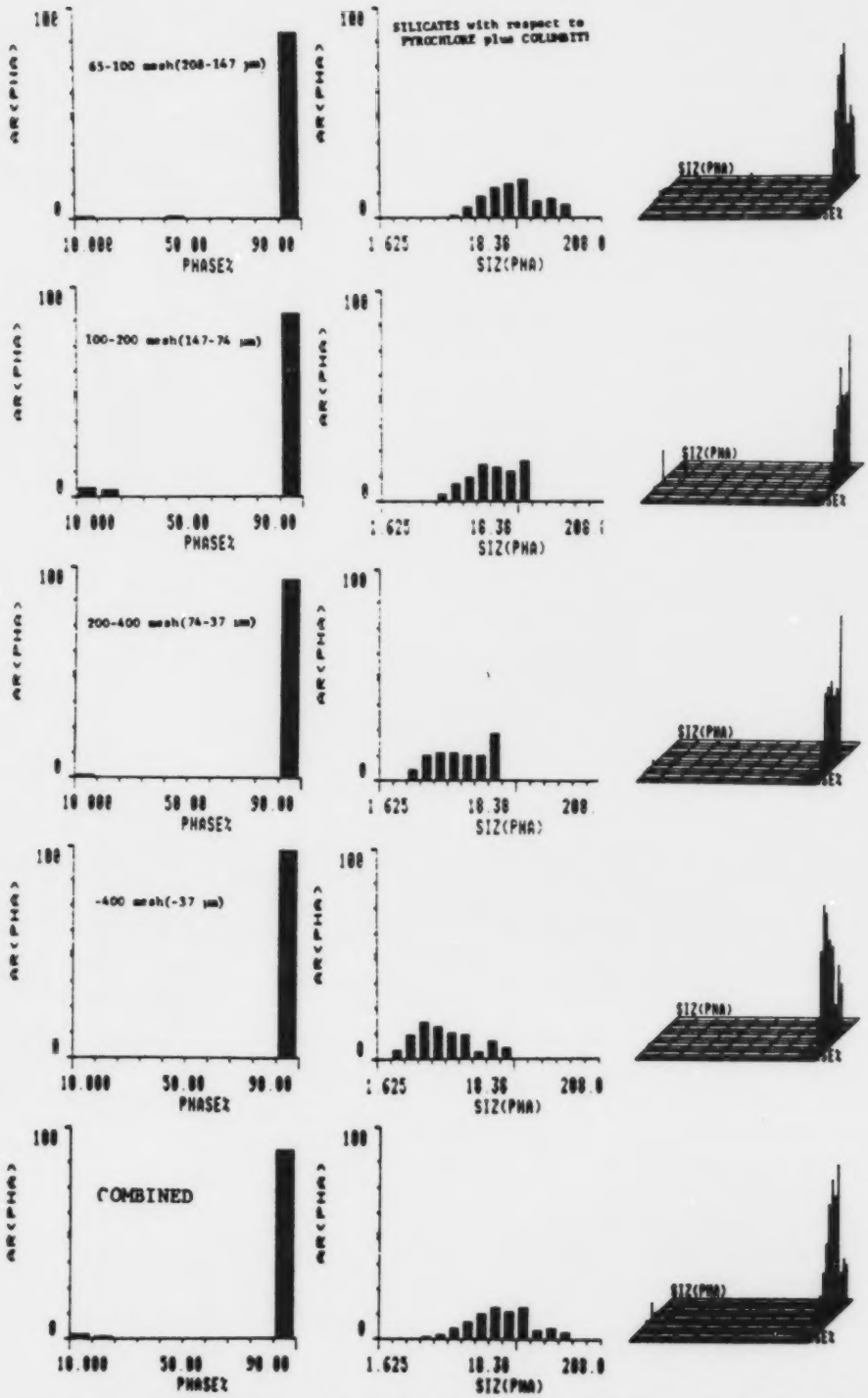

Fig. 11: Histograms giving classification of silicate minerals with respect to pyrochlore plus columbite and size distributions of free silicate minerals plus silicate minerals inclusions for screened samples and for combined data. The three dimensional diagrams show the size distribution for silicate minerals grains in each class of particle. The extreme right side of the diagram gives the size distribution of essentially free silicate minerals grains as seen in polished sections.

Table 4a: Data for classification and size distributions of pyrochlore with respect to all minerals. These data were used to plot the histograms and 3D diagrams of Fig. 1. Top=data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample. Top row gives classification, bottom is summary data for classification, left column = sizes; right column = summary size distribution.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	.313E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.508E-02	.831E-02
9.19	.125E-01	.645E-02	0.00	.254E-02	0.00	0.00	0.00	0.00	0.00	.402E-01	.617E-01
13.0	.471E-01	.129E-01	.840E-02	.469E-02	.723E-02	.508E-02	.332E-02	.352E-02	.488E-02	.154	.251
18.4	.735E-01	.332E-01	.193E-01	.586E-02	0.00	0.00	0.00	.166E-01	.664E-02	.350	.586
26.0	.227	.120	.561E-01	.723E-01	0.00	.186E-01	0.00	.262E-01	.242E-01	.667	1.21
36.8	.361	.370	.222	.594E-01	.676E-01	.117	.547E-01	.537E-01	.918E-01	1.35	2.75
52.0	.177	.414	.548	.265	.294	.299	.187	.168	.490	3.95	6.39
73.5	.840E-01	.477	1.04	.983	.568	.499	.777	.479	.550	4.51	9.96
104.	.188	.186	1.14	1.72	2.83	2.21	2.52	2.34	2.77	15.9	31.6
147.	0.00	0.00	.688	.350	1.12	3.89	0.00	0.00	4.64	18.6	29.2
208.	0.00	0.00	0.00	0.00	.678	2.32	0.00	0.00	.878	14.0	17.9
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.16	1.62	3.72	3.46	5.56	9.27	3.54	3.89	9.46	59.1	100.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.179E-01	.179E-01
6.50	.477E-01	.776E-02	0.00	0.00	0.00	.537E-02	0.00	0.00	0.00	.468E-01	.107
9.19	.125E-01	0.00	0.00	0.00	.227E-01	0.00	0.00	.191E-01	.239E-01	.171	.246
13.0	.188	0.00	.752E-01	0.00	.328E-01	.480E-01	0.00	0.00	0.00	.194	.532
18.4	.286	.142	.686E-01	.728E-01	0.00	.764E-01	.132	0.00	.645E-01	.755	1.60
26.0	.336	.871	0.00	.138	.260	0.00	.469	.260	.210	.458	2.97
36.8	.274	.772	.245	.859	0.00	0.00	0.00	.673	.794	2.13	5.75
52.0	0.00	.464	1.47	.845	0.00	0.00	.948	0.00	.448	8.84	13.0
73.5	0.00	0.00	0.00	4.20	1.64	1.03	4.24	2.05	3.01	14.8	30.9
104.	0.00	1.54	0.00	0.00	4.31	2.62	5.47	0.00	2.99	12.4	29.4
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.12	11.3	15.5
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.14	3.79	1.86	6.11	6.26	3.78	11.3	3.01	11.7	51.1	100.

Table 4b: Data for classification and size distributions of pyrochlore with respect to all minerals. These data were used to plot the histograms and 3D diagrams of Fig. 1. Top table is for 200-400 mesh (74-37 μm) sample and the bottom table is for the -400 mesh (-37 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
.189E-01	0.00	.384E-03	0.00	0.00	0.00	0.00	0.00	0.00	.276E-01	.226E-01
2.30										
.965E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.138E-01	.234E-01
3.25										
.698E-01	.512E-02	.653E-02	0.00	.152E-01	0.00	0.00	0.00	.789E-02	.403E-01	.134
4.60										
.496E-01	.383E-01	.847E-02	.183E-01	0.00	.311E-01	0.00	.246E-01	.114E-01	.748E-01	.174
6.50										
.121	.181	.738E-01	0.00	.201E-01	.685E-01	0.00	.555E-01	.343E-01	.216	.771
9.19										
.238	.243	.277	.277	0.00	.106	.143	.841E-01	.130	.471	1.97
13.0										
.221	.383	.471	.622	.285	.446	.339	.498	.484	2.29	5.84
18.4										
0.00	.548	.488	.322	.846	1.44	1.30	1.29	3.47	10.2	17.7
26.0										
0.00	1.25	.882	1.05	2.30	1.37	2.42	3.58	5.07	29.7	38.7
36.8										
0.00	0.00	.700	0.00	.601	1.16	2.30	4.01	4.54	11.6	34.9
52.0										
0.00	0.00	0.00	0.00	1.10	1.11	0.00	1.21	1.06	3.32	7.75
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.718	2.57	2.71	2.29	5.17	5.73	6.50	10.7	14.7	48.9	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.749E-02	0.00	.128E-02	0.00	0.00	0.00	0.00	0.00	0.00	.957E-03	.973E-02
1.62										
.150E-01	.749E-02	.175E-02	0.00	0.00	0.00	0.00	0.00	0.00	.111E-01	.356E-01
2.30										
.271E-01	.670E-02	.797E-02	.510E-02	.191E-01	.399E-02	0.00	.399E-02	0.00	.153E-01	.893E-01
3.25										
.453E-01	.254E-01	.104E-01	.140E-01	.266E-01	0.00	.161E-01	.325E-02	0.00	.845E-01	.232
4.60										
.448E-01	.305E-01	.631E-01	.496E-01	.277E-01	.440E-01	.321E-01	.456E-01	.650E-01	.122	.525
6.50										
.150	.240	.216	.360E-01	.126	.603E-01	.113	.467E-01	.335E-01	.274	1.30
9.19										
.130	.488	.435	.451	.228	.196	.286	.627	.673	1.37	4.73
13.0										
0.00	1.01	1.22	.547	1.78	1.09	.983	1.35	1.77	3.61	13.3
18.4										
0.00	.469	.820	.886	2.57	1.39	2.57	2.02	6.71	8.7	31.0
26.0										
0.00	0.00	.478	.344	.995	1.5.	1.62	4.01	10.2	..0	32.5
36.8										
0.00	0.00	0.00	0.00	0.00	.93a	2.03	1.72	5.75	4.19	14.7
52.0										
0.00	0.00	0.00	0.00	0.00	1.6.	0.00	0.00	0.00	..00	1.61
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.419	4.19	5.24	4.45	5.69	4.65	7.63	10.6	25.4	7..3	100.0

Table 4c: Combined data from all screened samples. These data were used for classification of pyrochlore with respect to all minerals and for plotting the histograms and 3D diagrams of Fig. 1.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.264E-03	0.00	.458E-04	0.00	0.00	0.00	0.00	0.00	0.00	.337E-04	.343E-03
1.62										
.384E-02	.264E-03	.193E-03	0.00	0.00	0.00	0.00	0.00	0.00	.765E-03	.426E-02
2.38										
.224E-02	.236E-03	.281E-03	.188E-03	.674E-03	.140E-03	0.00	.140E-03	0.00	.237E-02	.628E-02
3.25										
.958E-02	.157E-02	.123E-02	.494E-03	.295E-02	0.00	.568E-03	.326E-03	.942E-03	.129E-01	.386E-01
4.60										
.223E-01	.719E-02	.335E-02	.308E-02	.978E-03	.723E-02	.113E-02	.488E-02	.382E-02	.201E-01	.741E-01
6.50										
.318E-01	.363E-01	.174E-01	.272E-02	.131E-01	.112E-01	.399E-02	.148E-01	.111E-01	.106	.247
9.19										
.110	.540E-01	.765E-01	.554E-01	.297E-01	.342E-01	.281E-01	.353E-01	.438E-01	.249	.787
13.0										
.146	.132	.134	.124	.977E-01	.117	.114	.123	.137	.828	1.95
18.4										
.217	.384	.992E-01	.146	.270	.251	.385	.325	.765	2.34	5.18
26.0										
.278	.579	.324	.438	.388	.383	.410	.850	1.29	4.50	9.35
36.8										
.102	.357	.789	.371	.248	.358	.732	.689	1.20	6.01	10.9
52.0										
.481E-01	.273	.596	1.65	.891	.757	1.54	.967	1.24	6.85	14.8
73.5										
.103	.585	.652	.985	2.74	1.95	2.86	1.34	2.36	12.4	25.8
104.										
0.00	0.00	.394	.291	.648	2.17	0.00	0.00	3.73	13.6	20.7
147.										
0.00	0.00	0.00	0.00	.388	1.33	0.00	0.00	.583	6.01	10.2
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.07	2.33	3.09	3.97	5.69	7.29	6.08	4.35	11.3	54.8	100.0

Table 5a: Data for classification and size distributions of Na pyrochlore with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 2. Top=data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.38										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.656E-02	.656E-02
6.50										
.111	.290E-01	0.00	.711E-02	.164E-01	.547E-02	.601E-02	.137E-01	.656E-02	.388E-01	.434
9.19										
.153	.541E-01	.525E-01	.437E-01	.230E-01	.317E-01	.213E-01	.372E-01	.503E-01	.168	.634
13.0										
.237	.102	.143	.749E-01	.399E-01	.432E-01	0.00	.110	.683E-01	.324	1.14
18.4										
.588	.222	.415	.194	.109	.165	.711E-01	.279	.150	.294	2.49
26.0										
.382	.399	.377	.323	.599	.525	0.00	.344	.506	1.21	4.66
36.8										
.301	.469	.887	1.28	.327	.722	1.35	.838	1.24	1.71	9.19
52.0										
0.00	.718	.306	1.36	1.75	1.34	1.72	2.10	3.21	2.35	14.8
73.5										
0.00	0.00	0.00	.794	3.98	3.29	3.62	7.69	4.61	10.4	33.4
104.										
0.00	0.00	0.00	0.00	4.31	1.00	4.23	12.0	2.26	5.24	29.2
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	2.48	4.28
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.77	1.99	2.18	4.08	11.2	7.20	10.8	23.5	14.8	24.1	100.

DEF 077 061201 NTSREC 512*512

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.38										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25										
.387E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.387E-01
4.60										
.604E-01	.635E-01	0.00	.217E-01	0.00	0.00	.527E-01	0.00	0.00	.155E-01	.214
6.50										
.136	0.00	.125	.387E-01	0.00	.527E-01	.465E-01	0.00	0.00	.310E-01	.430
9.19										
.728E-01	.728E-01	.161	.774E-01	.798E-01	0.00	.929E-01	.968E-01	0.00	.867E-01	.739
13.0										
0.00	0.00	.223	.127	.388	.125	0.00	.170	.200	0.00	1.15
18.4										
.331	.612	.317	0.00	.254	0.00	.661	0.00	0.00	0.00	2.10
26.0										
.523	0.00	1.93	1.36	1.50	.894	1.27	2.23	1.50	0.00	11.2
36.8										
0.00	0.00	0.00	2.48	2.89	2.82	5.26	2.77	2.67	3.27	22.2
52.0										
0.00	2.00	0.00	0.00	2.44	6.05	1.97	2.88	4.47	1.94	21.7
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	12.5	6.44	0.00	21.2	40.1
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.16	2.75	2.76	4.18	7.48	9.94	21.8	14.6	8.84	26.5	100.0

Table 5b: Data for classification and size distributions of Na pyrochlore with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 2. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (-37 μm) sample.

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
.600E-01	.462E-02	.594E-02	.462E-02	0.00	0.00	0.00	.396E-02	.528E-02	.303E-01	.115
2.30										
.113	.191E-01	.185E-01	.534E-01	.924E-02	.792E-02	0.00	.119E-01	.224E-01	.581E-01	.313
3.25										
.398	.270E-01	.224E-01	.416E-01	.515E-01	.211E-01	0.00	0.00	.185E-01	.515E-01	.631
4.60										
.526	.224	0.00	.363E-01	.745E-01	.785E-01	0.00	.297E-01	0.00	.712E-01	1.04
6.50										
1.05	.495	.365	.208	.152	0.00	.142	0.00	0.00	0.00	1.31
9.19										
0.00	1.93	1.55	.723	.710	.497	.299	0.00	.433	.241	6.37
13.0										
0.00	.889	2.58	2.97	2.64	2.68	.952	0.00	.635	.852	14.1
18.4										
0.00	0.00	4.50	5.42	5.23	1.95	3.42	2.72	2.38	3.00	25.5
26.0										
0.00	0.00	0.00	0.00	.957	3.93	3.67	10.5	15.3	2.56	36.9
36.8										
0.00	0.00	0.00	0.00	1.74	2.09	0.00	1.77	2.71	4.31	12.6
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.15	3.51	8.95	9.46	11.6	11.3	8.47	15.0	21.4	8.18	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.779E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.230E-01	.101
1.62										
.192	.305E-01	0.00	0.00	0.00	0.00	0.00	.949E-02	.610E-02	.126	.364
2.30										
.571	.454E-01	.278E-01	.291E-01	0.00	.115E-01	0.00	0.00	0.00	.175	.860
3.25										
.894	.257	0.00	.113	.725E-01	.359E-01	0.00	0.00	0.00	.220	1.59
4.60										
1.85	.665	.232	.522E-01	.232	.143	0.00	.671E-01	0.00	.585	3.74
6.50										
1.58	1.46	.930	.844	.667	.131	.108	0.00	0.00	.436	5.80
9.19										
.261	2.15	4.12	2.10	2.54	1.21	.943	.228	.240	.654	14.4
13.0										
0.00	0.00	3.00	5.76	5.23	3.35	2.64	3.23	1.25	.524	25.0
18.4										
0.00	0.00	0.00	6.08	2.49	4.96	1.19	8.03	2.35	0.00	26.0
26.0										
0.00	0.00	0.00	0.00	0.00	4.77	0.00	9.81	1.90	1.75	18.2
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.83	0.00	3.83
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.34	4.61	8.31	15.6	11.2	14.6	4.88	21.4	9.58	4.42	100.0

Table 5c: Combined data from all screened samples. These data were used for classification of Na pyrochlore with respect to pyrochlore plus columbite, and for plotting the histograms and 3D diagrams of Fig. 2.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.125E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.369E-03	.162E-02
1.62										
.886E-02	.933E-03	.573E-03	.445E-03	0.00	0.00	0.00	.534E-03	.607E-03	.494E-02	.169E-01
2.38										
.200E-01	.257E-02	.223E-02	.562E-02	.891E-03	.948E-03	0.00	.115E-02	.216E-02	.841E-02	.448E-01
3.25										
.644E-01	.673E-02	.216E-02	.582E-02	.612E-02	.261E-02	0.00	0.00	.178E-02	.848E-02	.981E-01
4.60										
.986E-01	.515E-01	.371E-02	.109E-01	.109E-01	.986E-02	.159E-01	.394E-02	0.00	.235E-01	.229
6.50										
.231	.881E-01	.783E-01	.462E-01	.349E-01	.212E-01	.338E-01	.888E-02	.384E-02	.390E-01	.584
9.19										
.115	.274	.295	.152	.146	.858E-01	.836E-01	.544E-01	.751E-01	.158	1.44
13.0										
.139	.138	.448	.461	.455	.375	.134	.167	.182	.288	2.78
18.4										
.444	.315	.773	.746	.685	.364	.591	.555	.347	.172	4.99
26.0										
.382	.233	.806	.599	.897	1.03	.739	2.05	2.26	.982	9.97
36.8										
.176	.274	.519	1.50	1.23	1.48	2.38	1.53	1.86	2.48	13.4
52.0										
0.00	1.02	.179	.794	1.76	2.61	1.68	2.10	3.23	1.96	15.3
73.5										
0.00	0.00	0.00	.465	2.33	1.92	5.31	6.45	2.70	12.5	31.7
104.										
0.00	0.00	0.00	0.00	2.52	.634	2.47	7.04	1.32	3.07	17.1
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	1.48	2.51
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.68	2.41	3.11	4.79	10.1	8.54	13.4	28.0	13.1	23.0	100.

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Table 6a: Data for classification and size distributions of Ti pyrochlore with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 3. Top=data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) samples.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.38										
.982E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.982E-03
3.25										
.884E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.884E-02
4.60										
.422E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.422E-01
6.50										
.295	.334E-0.	.324E-01	.295E-01	.167E-0:	.255E-0:	0.00	.246E-0:	.265E-01	.382E-0:	.491
9.19										
.480	.198	.161	0.00	.383E-01	.766E-01	.422E-01	.3o3E-0:	0.00	0.00	..0+
13.0										
.738	.426	.221	.184	.244	.141	.874E-0:	.126	.363E-01	0.00	3.89
18.4										
.613	.529	.734	.318	.478	.464	.582	.181	.658E-01	0.00	3.96
26.0										
1.35	3.48	1.65	2.13	1.63	.662	.843	.666	.139	0.00	12.6
36.8										
.438	3.80	4.82	1.81	2.85	1.31	1.39	0.00	.316	0.00	16.7
52.0										
0.00	4.42	5.86	5.98	4.74	4.28	2.46	1.92	0.00	0.00	29.7
73.5										
0.00	0.00	3.58	4.36	4.76	10.1	1.96	.967	0.00	0.00	25.7
104.										
0.00	0.00	0.00	0.00	4.25	0.00	0.00	3.32	0.00	0.00	7.57
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.96	12.9	17.1	14.8	19.0	17.0	7.36	7.26	.634	.982E-02	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.38										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25										
.140	.294E-0:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.163
4.60										
.378	0.00	0.00	0.00	.110	0.00	.698E-01	0.00	0.00	0.00	.566
6.50										
.340	.202	.209	.265	.114	0.00	.107	.121	0.00	0.00	1.56
9.19										
.970	0.00	.191	.220	.716	1.07	1.05	.184	0.00	0.00	4.42
13.0										
3.76	.540	1.73	0.00	0.00	0.00	.500	0.00	0.00	0.00	6.53
18.4										
2.76	2.14	.621	1.43	.812	0.00	.830	0.00	0.00	0.00	8.69
26.0										
0.00	3.43	6.34	5.16	5.47	1.67	0.00	0.00	0.00	0.00	22.1
36.8										
0.00	2.87	2.95	8.71	3.06	3.23	3.98	0.00	0.00	0.00	24.8
52.0										
0.00	0.00	6.73	4.89	6.32	0.00	0.00	0.00	0.00	0.00	17.9
73.5										
0.00	0.00	0.00	0.00	0.00	13.4	0.00	0.00	0.00	0.00	13.4
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.55	9.21	18.8	28.7	16.6	19.3	6.54	.385	0.00	0.00	100.0

Table 6b: Data for classification and size distributions of Ti pyrochlore with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 3. Top table is for 200-400 mesh (74-37 μm) sample and the bottom table is for the -400 mesh (-37 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.801E-02	0.00	0.00	0.00	0.00	.404E-02	0.00	0.00	0.00	0.00	.120E-01
1.62										
.721E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.721E-01
2.30										
.258	.520E-01	0.00	.180E-01	0.00	.160E-01	0.00	0.00	0.00	0.00	.344
3.25										
.587	.126	.111	.641E-01	0.00	.260E-01	.230E-01	0.00	0.00	0.00	.852
4.60										
1.29	.270	.226	.150	.741E-01	.981E-01	.500E-01	0.00	0.00	0.00	3.16
6.50										
2.55	1.76	.893	.382	.257	.841E-01	0.00	0.00	0.00	0.00	5.90
9.19										
1.53	3.77	5.35	2.74	.922	.962	.554	0.00	.210	0.00	16.0
13.0										
.481	5.33	6.48	7.27	5.70	1.65	1.28	.483	0.00	0.00	28.6
18.4										
0.00	0.00	5.32	16.1	4.76	4.41	3.06	1.35	0.00	0.00	35.0
26.0										
0.00	0.00	1.32	2.23	4.15	1.25	0.00	2.00	0.00	0.00	11.0
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.70	11.3	19.6	29.0	15.9	8.58	4.96	3.63	.210	0.00	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.315E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.315E-01
1.62										
.116	.180E-01	.383E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.172
2.30										
.346	.443E-01	.375E-01	.323E-01	.435E-01	.203E-01	.348E-01	0.00	0.00	0.00	.555
3.25										
.898	.211	.312	.142	.380E-01	.375E-01	0.00	0.00	0.00	0.00	1.63
4.60										
1.90	1.07	1.24	.238	.101	0.00	0.00	0.00	0.00	0.00	4.55
6.50										
1.37	3.61	1.95	1.32	1.44	0.00	.128	0.00	0.00	0.00	9.81
9.19										
1.44	5.84	6.40	3.99	3.62	1.90	.555	0.00	0.00	0.00	23.7
13.0										
0.00	2.84	4.76	13.6	9.04	5.39	.533	1.18	0.00	0.00	37.1
18.4										
0.00	0.00	1.78	1.95	7.56	2.36	1.29	1.33	0.00	0.00	16.2
26.0										
0.00	0.00	0.00	1.72	1.86	0.00	0.00	2.45	0.00	0.00	6.03
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.10	13.6	16.4	22.9	23.7	9.71	2.54	4.96	0.00	0.00	100.0

Table 6c: Combined data from all screened samples. These data were used for classification of Ti pyrochlore with respect to pyrochlore plus columbite and for plotting the histograms and 3D diagrams of Fig. 3.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.121E-02	0.00	0.00	0.00	0.00	.272E-03	0.00	0.00	0.00	0.00	.148E-02
1.62										
.805E-02	.379E-03	.806E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.923E-02
2.30										
.288E-01	.447E-02	.790E-03	.190E-02	.916E-03	.151E-02	.648E-03	0.00	0.00	0.00	.382E-01
3.25										
.107	.224E-01	.170E-01	.160E-01	.632E-03	.976E-02	.876E-02	0.00	0.00	0.00	.181
4.60										
.250	.831E-01	.660E-01	.690E-01	.183E-01	.229E-01	.772E-02	0.00	0.00	.504E-02	.522
6.50										
.630	.352	.157	.100	.969E-01	.686E-01	.545E-01	.716E-02	.185E-01	.286E-02	1.49
9.19										
.739	.648	.831	.468	.264	.225	.100	.101	.337E-01	0.00	3.41
13.0										
1.54	1.14	1.31	1.22	.678	.398	.198	.167	.186E-01	.363E-01	6.70
18.4										
1.36	2.49	1.58	1.91	1.32	1.04	.651	.243	.768E-01	0.00	10.7
26.0										
1.60	4.37	4.26	4.38	2.69	1.32	.953	.924	.350	0.00	20.8
36.8										
.618	2.86	4.68	4.29	5.12	2.08	.484	.389	.922E-01	0.00	20.5
52.0										
0.00	1.84	1.71	4.82	4.46	4.82	3.88	.561	0.00	.453	22.5
73.5										
0.00	0.00	1.04	1.27	2.63	4.04	.571	1.46	0.00	0.00	11.0
104.										
0.00	0.00	0.00	0.00	1.24	0.00	0.00	.967	0.00	0.00	2.21
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.89	13.8	15.7	18.5	18.5	14.0	6.83	4.74	.581	.497	100.0

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Table 7a: Data for classification and size distributions of Fe plus Sr + Y pyrochlore with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 4. Top=data is for 65-100 mesh (208-147 μm) and the bottom data is for the 100-200 mesh (147-74 μm) samples.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
	.232E-02	.387E-02	.155E-02	0.00	.116E-02	0.00	0.00	0.00	0.00	0.00	.893E-02
1.62	0.00	0.00	.232E-02	0.00	0.00	0.00	0.00	0.00	0.00	.816E-01	.839E-01
2.30	.159E-01	0.00	.503E-02	.116E-01	.928E-02	.580E-02	.619E-02	0.00	0.00	.191	.245
3.25	.928E-02	.344E-01	0.00	.251E-01	.321E-01	.128E-01	.437E-01	.228E-01	0.00	.710	.899
4.60	.862E-01	.430E-01	.615E-01	.410E-01	.944E-01	.333E-01	.909E-01	.456E-01	.379E-01	1.26	1.73
6.50	.284	.658	.321	.360	0.00	.154	.406E-01	.859E-01	.126	1.55	3.48
9.19	.523	1.02	1.03	.803	.319	.281	.150	.285	.257	2.78	8.26
13.0	0.00	1.33	2.23	2.50	2.10	2.18	1.57	.763	.824	5.47	13.0
18.4	0.00	.296	1.84	3.52	2.31	3.60	3.82	4.14	2.22	6.75	28.5
26.0	0.00	0.00	.641	.671	1.99	2.49	4.00	3.43	1.78	12.1	27.1
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	2.13	3.62	8.26
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.37	2.37
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	.841	4.19	6.14	7.94	6.86	8.75	9.72	11.3	7.36	38.9	100.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
	.114E-02	.572E-03	.114E-02	0.00	0.00	0.00	0.00	0.00	0.00	.497E-01	.526E-01
1.62	.543E-02	0.00	0.00	.629E-02	.457E-02	0.00	0.00	0.00	0.00	.228	.244
2.30	.629E-02	.801E-02	.715E-02	0.00	.686E-02	.858E-02	.944E-02	.944E-02	0.00	.481	.517
3.25	.192E-01	0.00	.266E-01	.349E-01	0.00	.274E-01	.357E-01	.523E-01	.317E-01	.913	1.14
4.60	.826E-01	.184	.102	.792E-01	.232E-01	.869E-01	.133	.111	.103	1.25	2.14
6.50	.403E-01	1.03	.807	.276	.674	.409	.138	.288	.158	1.54	5.37
9.19	.284	1.83	1.46	1.88	.644	1.20	.962	.765	.837	3.86	13.7
13.0	0.00	.787	1.54	2.28	4.81	3.81	1.32	1.55	3.74	5.43	23.7
18.4	0.00	0.00	.738	1.71	1.58	1.43	5.10	2.50	2.67	18.6	36.3
26.0	0.00	0.00	0.00	0.00	.725	0.00	1.51	1.44	8.25	11.9	23.8
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.44	1.55	2.99
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	.359	3.84	4.68	6.27	7.66	6.16	9.21	6.71	19.3	39.8	100.0

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Table 7b: Data for classification and size distributions of Fe plus Sr + Y pyrochlore with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 4. Top table is for 200-400 mesh (74-37 μm) sample and the bottom table is for the -400 mesh (-37 μm) sample.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	.436E-02	.873E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.524E-02
4.60	.916E-02	.873E-02	.131E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.131E-01
6.50	.481E-01	.135E-01	.44E-01	.262E-02	.218E-02	0.00	0.00	0.00	0.00	.105E-01	.3.4[illegible]
9.19	.762E-01	.362E-01	.496E-01	.140E-01	.638E-02	.960E-02	.524E-02	0.00	0.00	.695	.46[illegible]
13.0	.174	.115	.30[illegible]	.279E-01	.367E-01	.484E-01	.105E-01	0.00	0.00	.973	1.4[illegible]
18.4	.446	.189	.175	.134	.868E-01	.108	.432E-01	.851E-01	.223E-01	1.66	2.74
26.0	.595	.652	.229	.153	.650E-01	.109	.173	.214	.216	4.34	4.0[illegible]
36.8	.918	.790	.766	.432	.304	.453	.152	.465	.539	3.49	8.21
52.0	.405	1.48	1.24	.587	.274	.371	1.04	.925	.822	5.11	[illegible]
73.5	.725	2.34	4.72	2.09	1.55	1.70	.760	.855	1.55	7.03	2.[illegible]
104.	0.00	0.00	0.00	2.25	1.34	2.26	.973	3.56	1.40	14.1	26.5
147.	0.00	0.00	0.00	0.00	.866	1.53	1.84	1.49	2.03	6.76	14.6
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.61	0.00	3.45	7.06
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.65	5.62	5.22	5.70	5.13	6.67	5.20	11.2	6.62	46.0	100.0

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	.262E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.262E-02
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	.655E-02	.787E-02	0.00	.223E-01	0.00	0.00	0.00	0.00	0.00	.148	.185
6.50	.367E-01	0.00	.839E-02	.315E-01	0.00	.236E-01	0.00	0.00	0.00	.579	.735
9.19	.341E-01	.642E-02	.115	.708E-01	.865E-01	.747E-01	.302E-01	0.00	0.00	1.02	1.50
13.0	.214	.839E-01	.190	.165	.131	.852E-01	.257	0.00	0.00	.945	2.07
18.4	.637	.266	.438	.164	.127	.347	.119	.367	0.00	1.97	4.44
26.0	.686	.869	1.33	.275	.488	.602	0.00	.859	.241	4.59	9.85
36.8	0.00	1.99	1.86	3.16	.730	1.05	.986	.448	0.00	8.12	15.3
52.0	0.00	2.35	2.18	.971	2.37	6.14	1.19	2.59	.876	6.74	25.4
73.5	0.00	0.00	1.98	0.00	2.49	0.00	0.00	2.53	0.00	24.8	33.8
104.	0.00	0.00	0.00	0.00	3.97	4.65	0.00	0.00	0.00	0.00	8.62
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1.62	5.63	8.17	4.86	10.3	13.0	2.28	6.79	1.12	45.9	[illegible]

Table 7c: Combined data from all screened samples. These data were used for classification of Fe plus Sr + Y pyrochlore with respect to pyrochlore plus columbite and for plotting the histograms and 3D diagrams of Fig. 4.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
	.672E-03	.308E-03	.145E-03	0.00	.883E-04	0.00	0.00	0.00	0.00	.121E-02	.242E-02	1.62
	.107E-02	0.00	.177E-03	.152E-03	.111E-03	0.00	0.00	0.00	0.00	.117E-01	.132E-01	2.38
	.541E-02	.166E-02	.118E-02	.198E-02	.158E-02	.649E-03	.700E-03	.229E-03	0.00	.257E-01	.390E-01	3.25
	.868E-02	.122E-01	.425E-02	.375E-02	.775E-02	.158E-02	.419E-02	.300E-02	.769E-03	.137	.184	4.60
	.253E-01	.290E-01	.199E-01	.147E-01	.198E-01	.979E-02	.284E-01	.616E-02	.538E-02	.432	.583	6.50
	.779E-01	.122	.931E-01	.586E-01	.461E-01	.489E-01	.358E-01	.300E-01	.119E-01	.744	1.27	9.19
	.224	.323	.192	.199	.186	.942E-01	.785E-01	.822E-01	.519E-01	1.49	2.83	13.0
	.320	.477	.415	.428	.432	.388	.194	.212	.381	2.21	5.37	18.4
	.884	.977	.594	.625	.512	.500	.595	.478	.538	2.86	8.54	26.0
	.381	1.72	1.25	.968	1.21	.828	.715	.919	.669	5.27	13.9	36.8
	.101	1.48	1.27	1.89	2.16	1.77	1.95	1.36	.912	6.35	19.3	52.0
	.562E-01	.887	1.18	1.88	1.26	1.22	2.04	1.26	2.00	12.5	24.2	73.5
	0.00	0.00	0.00	.562	1.46	1.02	.766	1.36	1.93	10.2	17.3	104.
	0.00	0.00	0.00	0.00	.216	.383	.458	.371	.522	2.69	4.63	147.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.901	0.00	.868	1.76	208.
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	2.09	5.95	5.02	6.64	7.44	6.26	6.65	6.98	6.93	45.8	100.	

Table 8a: Data for classification and size distributions of columbite with respect to all minerals. These data were used to plot the histograms and 3D diagrams of Fig. 5. Top data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30										
.759E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.759E-02
3.25										
.247E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.247E-01
4.60										
.180	.114E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.114E-01	.203
6.50										
.537	.399E-01	.266E-01	.209E-01	0.00	0.00	0.00	0.00	0.00	.235	.869
9.19										
.900	.285E-01	.380E-01	.323E-01	.399E-01	0.00	0.00	0.00	0.00	.524	1.56
13.0										
1.89	.163	.197	0.00	0.00	.607E-01	.569E-01	.835E-01	.692E-01	.123	2.67
18.4										
1.42	.349	.288	.114	.469	0.00	0.00	.129	0.00	.254	3.02
26.0										
2.06	1.15	.818	.549	.438	0.00	0.00	.522	.670	.628	6.83
36.8										
2.32	2.70	2.30	1.21	1.01	1.77	0.00	.573	1.06	.869	13.8
52.0										
0.00	2.39	4.29	5.00	.981	0.00	2.48	2.76	1.24	3.53	22.8
73.5										
0.00	0.00	0.00	4.36	5.01	5.65	2.94	3.90	3.70	1.94	27.5
104.										
0.00	0.00	0.00	0.00	3.62	0.00	0.00	8.29	5.36	3.41	20.7
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.33	6.82	7.96	11.4	11.6	7.48	5.48	16.3	12.1	11.6	100.

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10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.357E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.357E-02
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30										
.357E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.357E-01
3.25										
.214	.286E-01	0.00	0.00	.250E-01	0.00	0.00	0.00	0.00	.429E-01	.321
4.60										
.443	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.243	.686
6.50										
1.65	.100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.593	2.34
9.19										
.388	.622	0.00	.143	.343	.154	0.00	0.00	.275	.629	2.93
13.0										
2.91	0.00	.311	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.22
18.4										
1.74	.582	2.74	1.25	.654	0.00	1.00	.693	0.00	1.86	10.5
26.0										
1.76	1.68	1.66	0.00	2.21	0.00	0.00	0.00	1.47	1.14	9.92
36.8										
2.89	0.00	8.92	3.03	2.70	5.94	13.5	7.85	5.37	7.29	56.7
52.0										
0.00	0.00	0.00	0.00	0.00	13.7	0.00	0.00	0.00	0.00	13.7
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.0	3.01	13.6	4.42	5.93	19.8	14.5	7.74	7.12	11.8	100.0

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Table 8b: Data for classification and size distributions of columbite with respect to all minerals. These data were used to plot the histograms and 3D diagrams of Fig. 5. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (-37 μm) sample.

	10.00	20.0	30.0	42.0	58.0	60.0	70.0	80.0	90.0		
	.170E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.190E-01
1.62	.173	.671E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.221E-01	.200
2.30	.398	.794E-01	.313E-01	0.00	0.00	0.00	0.00	0.00	0.00	.939E-01	.603
3.25	.953	.604E-01	0.00	.391E-01	0.00	.626E-01	0.00	0.00	.235E-01	.122	1.26
4.60	2.59	.231	.100	.581E-01	0.00	0.00	.458E-01	0.00	0.00	.144	3.25
6.50	3.23	1.53	.551	.200	.247	0.00	.163	.379	0.00	0.00	6.30
9.19	2.26	3.24	2.76	.768	.836	.769	0.00	.231	0.00	0.00	10.9
13.0	2.97	5.67	4.27	2.30	2.94	.514	1.96	.477	0.00	1.65	22.7
18.4	0.00	3.74	3.90	6.03	3.39	2.75	2.71	3.68	.772	0.00	27.0
26.0	0.00	2.50	1.73	1.49	1.98	2.50	0.00	1.53	2.62	1.74	16.1
36.8	0.00	0.00	3.87	0.00	0.00	4.54	0.00	0.00	0.00	3.28	11.7
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	12.6	17.0	17.3	10.9	9.39	11.1	4.88	6.30	3.41	7.05	100.

	10.00	20.0	30.0	40.0	58.0	60.0	70.0	80.0	90.0		
	.867E-01	0.00	0.00	.461E-02	0.00	0.00	0.00	0.00	0.00	.46.E-02	.968E-01
1.62	.279	.107E-01	.691E-02	0.00	0.00	0.00	0.00	0.00	0.00	.968E-01	.392
2.30	.837	.691E-01	.114	.299E-01	.207E-01	.223E-01	0.00	.230E-01	0.00	.102	1.22
3.25	1.73	.223	.116	.192	.368E-01	.135	0.00	0.00	0.00	.388	2.74
4.60	3.90	1.03	.440	.157	.238	0.00	0.00	0.00	.363	.112	6.24
6.50	2.37	3.70	1.63	.106	0.00	.144	.286	.196	.133	.223	8.79
9.19	2.19	5.52	2.52	1.05	0.00	.867	.491	.393	.833	.276	14.1
13.0	3.67	7.59	5.06	4.45	3.62	.596	3.34	.751	2.54	1.83	34.0
18.4	0.00	2.35	1.53	1.97	7.27	3.58	1.13	0.00	2.09	1.42	21.3
26.0	0.00	0.00	0.00	2.02	0.00	2.15	0.00	3.91	0.00	2.14	11.2
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	15.1	20.5	12.3	10.6	11.2	7.49	5.24	5.28	3.46	4.71	100.0

Table 8c: Combined data from all screened samples. These data were used for classification of columbite with respect to all minerals, and for plotting the histograms and 3D diagrams of Fig. 5.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.121E-01	0.00	0.00	.353E-03	0.00	0.00	0.00	0.00	0.00	.353E-03	.128E-01
1.62										
.579E-01	.224E-02	.529E-03	0.00	0.00	0.00	0.00	0.00	0.00	.116E-01	.728E-01
2.30										
.165	.220E-01	.154E-01	.229E-02	.159E-02	.171E-02	0.00	.176E-02	0.00	.276E-01	.237
3.25										
.429	.416E-01	.888E-02	.230E-01	.131E-01	.235E-01	0.00	0.00	.495E-02	.669E-01	.611
4.60										
1.00	.131	.716E-01	.243E-01	.182E-01	0.00	.966E-02	0.00	.278E-01	.142	1.51
6.58										
1.70	.658	.249	.566E-01	.521E-01	.110E-01	.563E-01	.951E-01	.182E-01	.338	3.22
9.19										
1.07	1.37	.786	.311	.329	.292	.376E-01	.789E-01	.177	.438	4.89
13.0										
2.68	1.83	1.54	.811	.896	.172	.685	.183	.222	.527	9.54
18.4										
1.14	1.31	2.16	1.97	1.68	.854	1.07	1.18	.323	.951	12.6
26.0										
1.35	1.56	1.29	.694	1.46	.692	0.00	.779	1.36	1.19	10.4
36.6										
1.89	.811	5.18	1.61	1.41	3.93	5.56	3.87	2.54	3.95	30.0
52.0										
0.00	.718	1.29	1.53	.295	5.66	.746	.630	.372	1.68	12.5
73.5										
0.00	0.00	0.00	1.31	1.51	1.70	.884	1.17	1.11	.583	8.28
104.										
0.00	0.00	0.00	0.00	1.09	0.00	0.00	2.49	1.61	1.03	6.22
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11.6	8.46	12.6	8.34	8.76	13.3	9.05	9.81	7.76	10.3	100.

Table 9a: Data for classification and size distributions of columbite with respect to pyrochlore. These data were used to plot the histograms and 3D diagrams of Fig. 6. Top data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.38										
.759E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.759E-02
3.25										
.247E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.247E-01
4.60										
.171	.114E-0.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.228E-0:	.285
6.50										
.607	.778E-0:	.266E-01	.209E-01	.152E-01	.133E-01	0.00	0.00	0.00	.252	1.01
9.19										
.769	.384E-0:	.073E-01	.342E-01	.770E-01	.380E-01	0.00	0.00	0.00	.750	1.79
13.0										
1.24	.237	.195	.158	.233	.233	.501	.262	0.00	.512	3.57
18.4										
1.29	.416	.00	.235	.306	0.00	.129	0.00	0.00	.871	3.43
26.0										
1.23	.333	.456	.822	.687	.696	0.00	.786	.670	1.14	7.34
36.8										
.879	2.62	1.20	1.27	2.10	.949	0.00	0.00	2.72	2.91	14.7
52.0										
0.00	0.00	.938	4.18	.981	.915	.964	.930	3.11	8.04	20.1
73.5										
0.00	0.00	0.00	2.69	0.00	7.71	0.00	3.90	5.38	7.94	27.6
104.										
0.00	0.00	0.00	0.00	0.00	3.32	0.00	0.26	5.36	3.35	20.3
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.22	4.23	3.08	9.41	4.48	13.9	1.59	14.1	17.2	25.8	.00.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.357E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.357E-02
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.38										
.357E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.357E-01
3.25										
.214	.286E-0:	0.00	0.00	.250E-01	0.00	0.00	0.00	0.00	.429E-0:	.311
4.60										
.489	.393E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.418	.747
6.50										
1.45	.207	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.947	2.81
9.19										
.368	.622	0.00	.143	.175	.154	0.00	0.00	.275	1.56	3.29
13.0										
2.57	.347	.311	0.00	.550	0.00	0.00	0.00	0.00	.932	4.71
18.4										
.761	0.00	1.90	1.26	0.00	1.00	0.00	.693	0.00	6.43	12.0
26.0										
0.00	1.76	0.00	1.68	2.81	0.00	1.66	0.00	2.15	1.14	10.6
36.8										
0.00	0.00	2.29	3.03	0.00	0.00	7.62	6.52	11.9	24.0	55.4
52.0										
0.00	0.00	0.00	0.00	0.00	5.27	0.00	0.00	0.00	4.76	10.0
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.09	3.01	4.50	6.12	2.96	6.42	9.28	7.22	14.4	40.2	100.0

Table 9b: Data for classification and size distributions of columbite with respect to pyrochlore. These data were used to plot the histograms and 3D diagrams of Fig. 6. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (-37 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.190E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.92E-0
1.62										
.164	.157E-01	0.00	0.00	.703E-02	0.00	0.00	0.00	0.00	.593E-01	.247
2.30										
.389	.816E-01	.458E-01	0.00	0.00	0.00	0.00	0.00	0.00	.261	.777
3.25										
.876	.121	.391E-01	.615E-01	.313E-01	.850E-01	.414E-01	0.00	.235E-01	.335	1.61
4.60										
2.46	.294	.188	.548E-01	.155	.112	.104	0.00	0.00	.443	3.81
6.50										
2.99	1.41	.258	.812	.870	0.00	.578	.379	0.00	.767	8.07
9.19										
1.52	3.17	2.00	1.02	.859	.512	1.08	.419	.329	.264	11.2
13.0										
1.10	1.62	4.01	3.01	2.86	1.68	1.32	2.17	1.14	1.65	20.8
18.4										
0.00	2.98	0.00	6.03	1.44	4.59	.753	7.01	1.45	3.97	28.2
26.0										
0.00	0.00	1.73	0.00	5.79	2.50	1.55	1.53	2.62	1.74	17.5
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	4.54	0.00	0.00	3.28	7.82
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.51	9.30	8.27	11.0	12.0	9.49	9.97	11.5	5.57	12.8	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.875E-01	.384E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.207E-01	.112
1.62										
.238	.284E-01	.253E-01	.123E-01	0.00	0.00	0.00	0.00	.246E-01	.172	.474
2.30										
.782	.185	.493E-01	.476E-01	0.00	.415E-01	.368E-01	.238E-01	0.00	.263	1.37
3.25										
1.62	.273	.690E-01	.147	.135	.157	0.00	.353E-01	.356	.502	2.96
4.60										
3.43	1.32	.448	.502	.181	.137	0.00	.133	.133	.253	6.67
6.50										
1.55	3.67	1.70	.479	0.00	.144	.149	.464	.329	.643	8.93
9.19										
1.22	5.97	2.78	1.31	.463	.747	.888	.686	3.61	.989	15.4
13.0										
.989	4.58	6.84	4.89	3.88	.596	2.36	2.95	2.09	1.83	31.7
18.4										
0.00	0.00	0.00	5.86	3.33	3.75	2.04	3.78	1.42	1.42	22.2
26.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.04	2.14	2.14	18.2
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.83	16.0	11.1	13.3	7.91	5.57	5.46	16.0	6.34	8.23	100.0

Table 9c: Combined data from all screened samples. These data were used for classification of columbite with respect to pyrochlore and for plotting the histograms and 3D diagrams of Fig. 6.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.122E-01	.294E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.159E-02	.141E-01
1.62										
.528E-01	.540E-02	.194E-02	.941E-03	.165E-02	0.00	0.00	0.00	0.00	.257E-01	.884E-01
2.30										
.153	.314E-01	.135E-01	.365E-02	0.00	.318E-02	.282E-02	.176E-02	.188E-02	.750E-01	.286
3.25										
.404	.581E-01	.151E-01	.243E-01	.272E-01	.300E-01	.872E-02	.271E-02	.495E-02	.127	.702
4.60										
1.03	.183	.733E-01	.500E-01	.405E-01	.340E-01	.219E-01	.102E-01	.273E-01	.292	1.77
6.50										
1.53	.688	.192	.214	.188	.150E-01	.133	.115	.102E-01	.677	3.76
9.19										
.797	1.39	.660	.385	.312	.248	.296	.141	.208	.998	5.43
13.0										
1.74	.949	1.50	1.06	1.20	.478	.610	.763	.517	1.83	9.82
18.4										
.701	.754	.835	2.31	.652	1.67	.354	2.05	.466	3.86	13.6
26.0										
.371	.979	.502	.939	2.34	.738	1.01	1.18	1.64	1.34	11.0
36.8										
.264	.788	1.30	1.63	.632	.285	4.10	2.69	5.73	11.5	28.9
52.0										
0.00	0.00	.282	1.26	.295	2.44	.290	.280	.937	4.38	10.2
73.5										
0.00	0.00	0.00	.810	0.00	2.32	0.00	1.17	1.62	2.39	8.31
104.										
0.00	0.00	0.00	0.00	0.00	.999	0.00	2.49	1.61	1.01	6.11
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7.06	5.83	5.38	8.68	5.68	9.24	6.82	10.9	12.8	27.7	100.0

Table 10a: Data for classification and size distributions of hematite with respect to all minerals. These data were used to plot the histograms and 3D diagrams of Fig. 7. Top data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	.412E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.183E-02	.600E-02
9.19	.592E-01	.394E-02	.326E-02	0.00	0.00	0.00	0.00	0.00	0.00	.374E-01	.104
13.0	.125	.243E-01	.789E-02	0.00	0.00	.292E-02	0.00	0.00	0.00	.578E-01	.218
18.4	.228	.784E-01	.454E-01	.514E-02	.723E-02	0.00	.840E-02	.722E-02	.669E-02	.175	.566
26.0	.260	.193	.131	.856E-01	.909E-02	.345E-01	0.00	0.00	0.00	.416	1.13
36.8	.559	.500	.421	.135	.717E-01	.267E-01	.135	.249E-01	0.00	.743	2.62
52.0	.106	1.35	.823	.901	.463	.331	.561	.261	.180	1.92	6.90
73.5	.201	1.07	1.74	1.40	1.68	1.69	2.26	1.29	.866	3.61	15.8
104.	0.00	.341	1.08	2.36	3.37	3.50	2.59	2.95	2.65	7.48	26.3
147.	0.00	0.00	0.00	1.39	2.48	3.40	3.67	1.89	3.17	10.4	26.4
208.	0.00	0.00	0.00	.586	0.00	.623	.691	7.10	5.45	2.72	17.2
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.76	2.76
	1.54	3.57	4.25	6.87	8.08	9.68	9.92	13.5	12.3	30.3	100.0

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	.619E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	.359E-01	.132E-01	.537E-02	0.00	0.00	0.00	0.00	0.00	0.00	.372E-02	.991E-02
9.19	.120	.334E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.652E-01	.129
13.0	.134	.599E-01	0.00	.912E-01	0.00	0.00	0.00	0.00	0.00	.108	.261
18.4	.489	.288	.999E-01	.127	.438E-01	0.00	0.00	0.00	0.00	.242	.527
26.0	.333	.605	.238	0.00	.184	.244	0.00	0.00	0.00	.355	1.39
36.8	0.00	1.03	.353	.797	.861	.141	.206	.256	.978E-01	.696	2.31
52.0	0.00	.609	1.37	2.69	.275	1.16	.728	.487	.466	2.87	7.19
73.5	0.00	0.00	1.92	.803	2.06	4.45	5.21	3.02	2.32	5.92	13.6
104.	0.00	0.00	0.00	1.47	1.28	1.50	4.47	1.17	6.58	10.5	30.3
147.	0.00	0.00	0.00	0.00	0.00	2.32	3.37	2.62	0.00	15.2	31.6
208.	0.00	0.00	0.00	0.00	0.00	0.00	4.28	0.00	0.00	0.00	8.31
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.28
	1.12	2.63	3.58	5.98	4.63	9.62	18.3	7.48	18.1	36.0	100.

Table 10b: Data for classification and size distributions of hematite with respect to all minerals. These data were used to plot the histograms and 3D diagrams of Fig. 7. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (-37 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
.124E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.132E-01	.2197-2.
2.30										
.753E-01	.177E-02	0.00	0.00	.517E-02	.284E-02	.191E-02	0.00	0.00	.702E-01	.156
3.25										
.193	.871E-02	.436E-02	.381E-02	.463E-02	.286Z-02	0.00	.463E-02	0.00	.160	.363
4.60										
.364	.118E-01	.152E-01	.118E-01	.640E-02	.926E-02	.389E-01	.871E-02	.144E-01	.170	.651
6.50										
.470	.192	.889E-01	0.00	0.00	.139E-01	.131E-01	.568E-01	.317E-01	.228	1.09
9.19										
.240	.481	.261	.949E-01	.100	.135	.639E-01	.793E-01	.683E-01	.852	2.38
13.0										
.151	.787	.745	.585	.287	.463	.319	.320	.708	3.25	7.66
18.4										
.234	.294	.682	1.98	1.58	1.03	1.88	1.36	2.84	7.05	18.9
26.0										
0.00	0.00	.934	1.94	3.43	2.57	2.66	3.04	6.10	15.5	36.2
36.8										
0.00	0.00	.928	.396	.879	1.03	5.81	2.29	6.77	10.9	29.0
52.0										
0.00	0.00	0.00	0.00	.724	0.00	.741	0.00	0.00	.682	2.15
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.00	1.34
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.74	1.78	3.65	5.02	7.03	5.26	11.5	7.16	17.9	38.9	100.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.116E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.192E-01	.388E-01
1.62										
.587E-01	.683E-02	.228E-02	0.00	0.00	.212E-01	.163E-02	0.00	0.00	.737E-01	.145
2.30										
.175	.255E-01	.151E-01	.159E-01	.156E-01	.138E-01	0.00	.117E-01	.456E-02	.177	.454
3.25										
.358	.113	.556E-01	.716E-02	.428E-01	.781E-02	.151E-01	.944E-02	.151E-01	.136	.760
4.60										
.571	.752E-01	.293E-01	.213E-01	.428E-01	.423E-01	.856E-01	.124	.669E-01	.236	1.29
6.50										
.459	.527	.200	.825E-01	.220	.179	.122	.235	.255	.387	2.67
9.19										
.108	.438	.565	.161	.314	.466	.388	.563	.949	1.82	5.77
13.0										
.488	.667	1.91	1.62	1.30	1.21	1.77	3.03	2.63	4.56	19.1
18.4										
.186	.671	1.03	2.49	1.03	4.21	3.37	5.36	7.53	10.3	37.0
26.0										
0.00	0.00	.427	1.05	3.91	1.14	3.46	6.03	5.14	8.50	29.7
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.34	.753	3.14
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.34	2.52	4.23	5.45	7.68	7.28	9.21	15.4	18.9	27.8	100.0

Table 10c: Combined data from all screened samples. These data were used for classification of hematite with respect to all minerals and for plotting the histograms and 3D diagrams of Fig. 7.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.249E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.414E-03	.664E-03
1.62										
.345E-02	.147E-03	.492E-04	0.00	0.00	.456E-04	.351E-04	0.00	0.00	.397E-02	.770E-02
2.30										
.171E-01	.863E-03	.327E-03	.344E-03	.125E-02	.641E-03	.333E-03	.253E-03	.983E-04	.162E-01	.374E-01
3.25										
.439E-01	.397E-02	.197E-02	.827E-03	.174E-02	.673E-03	.327E-03	.188E-02	.327E-03	.289E-01	.837E-01
4.60										
.986E-01	.819E-02	.514E-02	.255E-02	.283E-02	.255E-02	.872E-02	.422E-02	.399E-02	.581E-01	.186
6.50										
.161	.583E-01	.281E-01	.178E-02	.475E-02	.632E-02	.493E-02	.151E-01	.111E-01	.182	.386
9.19										
.148	.126	.619E-01	.511E-01	.258E-01	.352E-01	.195E-01	.261E-01	.325E-01	.298	.824
13.0										
.387	.284	.227	.184	.967E-01	.186	.983E-01	.125	.195	.874	2.58
18.4										
.278	.361	.281	.443	.358	.372	.485	.335	.696	1.89	5.44
26.0										
.259	.579	.488	.698	1.01	.538	.676	.765	1.42	4.24	10.7
36.8										
.493E-01	.833	1.01	1.40	.463	.728	1.53	.663	1.49	4.84	13.0
52.0										
.938E-01	.497	1.46	.922	1.60	2.29	2.94	1.62	1.19	5.36	18.0
73.5										
0.00	.158	.581	1.59	2.00	2.13	2.71	1.76	3.69	8.61	23.2
104.										
0.00	0.00	0.00	.644	1.15	2.36	2.84	1.76	1.47	4.81	15.0
147.										
0.00	0.00	0.00	.271	0.00	.289	1.77	3.29	2.53	1.26	9.48
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	1.28
1.45	2.91	4.05	6.21	6.72	8.86	13.0	10.4	12.7	33.7	100.

Table 11a: Data for classification and size distributions of locked hematite with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 8. Top data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60										
.323E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.323E-01
6.50										
.483	.169E-0.	.293E-01	.154E-01	.209E-01	0.00	0.00	0.00	0.00	.185E-0:	.583
9.19										
.589	.692E-0:	.538E-0:	.292E-0:	.261E-0:	.261E-01	.277E-0:	0.00	0.00	.338E-0:	.775
13.0										
1.37	.151	.291	.148	0.00	.583E-0:	.218	.569E-0:	.569E-0:	0.00	2.35
18.4										
1.66	.292	.378	.830E-01	.277	0.00	.415	.211	.269	.169	3.76
26.0										
1.07	.166	.252	0.00	0.00	0.00	.711	.261	.671	0.00	3.13
36.8										
.437	0.00	1.23	.767	.475	.877	0.00	.747	2.70	.326	7.56
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	3.50	5.68	12.0
73.5										
0.00	0.00	0.00	1.41	1.63	1.66	0.00	1.65	9.83	11.9	28.1
104.										
0.00	0.00	0.00	0.00	0.00	4.00	0.00	0.00	0.00	14.3	18.3
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.4	23.4
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.56	.695	2.23	2.45	2.43	6.61	1.37	5.76	17.0	55.9	100.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25										
.964E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.964E-01
4.60										
.285	.629E-0:	.545E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.492
6.50										
.792	.365	0.00	0.00	0.00	.117	0.00	0.00	0.00	0.00	1.27
9.19										
.750	.222	0.00	.180	.268	0.00	0.00	0.00	0.00	0.00	1.42
13.0										
1.58	0.00	0.00	0.00	.444	0.00	0.00	0.00	0.00	.450	2.52
18.4										
1.14	.671	0.00	0.00	0.00	1.18	0.00	0.00	0.00	0.00	3.00
26.0										
0.00	0.00	0.00	0.00	0.00	0.00	2.29	0.00	2.56	4.05	8.89
36.8										
0.00	0.00	0.00	4.66	0.00	0.00	0.00	0.00	3.69	6.11	14.4
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	5.57	0.00	0.00	5.85	11.4
73.5										
0.00	0.00	0.00	0.00	0.00	12.5	0.00	0.00	0.00	14.9	17.4
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	29.2	0.00	29.2
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.65	1.32	.545E-01	4.64	.712	3.8	7.85	0.00	35.3	31.4	129.

Table 11b: Data for classification and size distributions of locked hematite with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 8. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (-37 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
.119	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.119
2.30										
.646	.401E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.258E-01	.712
3.25										
2.01	.516E-01	.616E-01	.401E-01	.487E-01	.731E-01	.487E-01	0.00	.459E-01	.215	2.53
4.60										
2.87	.523	.159	0.00	.291	0.00	0.00	.632E-01	.129	.140	4.26
6.50										
3.04	.815	.343	0.00	.126	.206	.120	0.00	0.00	0.00	4.65
9.19										
.622	1.46	.580	0.00	0.00	.504	0.00	0.00	0.00	.262	3.43
13.0										
.436	.559	.635	.443	0.00	1.35	0.00	0.00	.702	3.24	7.39
18.4										
0.00	.995	1.57	.301	0.00	0.00	0.00	.977	0.00	6.48	10.8
26.0										
0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00	24.1	31.1
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.6	0.00	15.4	35.1
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.75	4.45	3.34	1.38	.375	9.21	.169	20.6	.877	49.9	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.715E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.195E-0.	.910E-01
1.62										
.573	.211E-0:	0.00	0.00	0.00	0.00	.162E-0:	0.00	0.00	.162E-0:	.627
2.30										
1.64	.401	.455E-01	.114	.128	.128	0.00	.536E-01	0.00	.698E-0:	2.58
3.25										
3.92	.445	.310	.177	.219	0.00	0.00	.780E-01	.552E-01	.154	5.36
4.60										
5.24	.728	.346	.151	.500	.360	.231	.120	.339	.206	8.24
6.50										
2.75	2.24	1.04	.232	.591	0.00	0.00	0.00	0.00	.223	7.15
9.19										
1.04	1.44	.531	.853	0.00	0.00	.502	0.00	0.00	2.33	6.63
13.0										
1.19	0.00	1.19	3.54	1.33	0.00	1.45	2.20	1.21	3.33	15.4
18.4										
0.00	0.00	0.00	0.00	1.76	0.00	0.00	0.00	0.00	19.6	21.4
26.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.00	23.5	34.5
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16.4	5.28	3.47	5.12	4.53	.508	2.28	11.4	1.60	49.5	100.0

Table 11c: Combined data from all screened samples. These data were used for classification of locked hematite with respect to pyrochlore plus columbite, and for plotting the histograms and 3D diagrams of Fig. 8.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.133E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.364E-03	.178E-02
1.62										
.348E-01	.394E-03	0.00	0.00	0.00	0.00	.383E-03	0.00	0.00	.383E-03	.358E-01
2.38										
.161	.156E-01	.849E-03	.212E-02	.239E-02	.239E-02	0.00	.168E-02	0.00	.652E-02	.192
3.25										
.587	.187E-01	.163E-01	.114E-01	.148E-01	.148E-01	.986E-02	.145E-02	.183E-01	.464E-01	.652
4.60										
.776	.138	.544E-01	.282E-02	.499E-01	.709E-02	.438E-02	.144E-01	.324E-01	.323E-01	1.11
6.50										
1.13	.321	.183	.138E-01	.464E-01	.757E-01	.244E-01	0.00	0.00	.132E-01	1.73
9.19										
.611	.421	.154	.823E-01	.983E-01	.115	.229E-01	0.00	0.00	.113	1.61
13.0										
1.24	.187	.293	.228	.153	.299	.134	.698E-01	.193	.868	3.66
18.4										
1.15	.538	.582	.223	.169	.341	.283	.281	.132	1.76	5.30
26.0										
.522	.814E-01	.124	0.00	0.00	1.43	1.01	.295	1.07	6.48	11.0
36.8										
.214	0.00	.681	1.72	.233	.438	0.00	4.34	2.37	5.05	15.0
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	1.61	1.39	1.72	4.48	9.19
73.5										
0.00	0.00	0.00	.692	.797	4.42	0.00	.887	4.82	10.2	21.7
104.										
0.00	0.00	0.00	0.00	0.00	1.96	0.00	0.00	8.43	6.99	17.4
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.5	11.5
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.35	1.72	1.85	2.96	1.55	9.18	3.02	7.20	18.8	47.5	100.0

Table 12a: Data for classification and size distributions of carbonate minerals with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 9. Top data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.19	.255	.271E-01	.157E-01	0.00	.185E-01	0.00	0.00	0.00	0.00	.856E-02	.856E-02
13.0	.666	.371E-01	.121	.140	.742E-01	.870E-01	.243E-01	0.00	0.00	.114	.431
18.4	1.06	.398	.110	.131	0.00	.399E-01	.113	.742E-01	.728E-01	.340	1.49
26.0	1.90	.512	.913E-01	.385	.180	.118	0.00	.234	0.00	.913	2.91
36.8	1.05	2.09	1.17	1.02	0.00	.240	.382	0.00	.900	1.10	4.44
52.0	1.04	1.11	3.49	1.32	1.40	0.00	.332	.526	.494	1.47	7.89
73.5	.646	1.75	3.05	4.54	.735	4.58	4.20	1.13	3.49	1.63	11.3
104.	0.00	0.00	0.00	0.00	3.58	1.79	5.99	0.00	3.06	5.55	29.7
147.	0.00	0.00	0.00	0.00	0.00	2.65	6.89	0.00	0.00	9.30	24.3
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.47	0.00	2.69	12.1
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.47
	6.60	5.93	8.85	7.45	5.98	9.58	17.9	7.43	8.02	23.1	100.0

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	.188	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.188
6.50	.235	.998E-01	.998E-01	0.00	0.00	0.00	0.00	0.00	0.00	.411	.346
9.19	1.05	0.00	.141	.296	0.00	0.00	0.00	0.00	0.00	.810	2.21
13.0	1.49	.634	.449	.317	.546	0.00	0.00	0.00	0.00	.449	3.87
18.4	2.90	1.32	.493	0.00	0.00	0.00	0.00	0.00	.893	1.67	7.30
26.0	0.00	2.33	0.00	0.00	2.11	2.17	0.00	1.29	1.15	2.22	11.3
36.8	3.18	0.00	0.00	8.14	2.87	4.95	3.08	5.81	0.00	2.94	31.0
52.0	0.00	0.00	4.66	4.00	5.00	9.14	4.68	0.00	6.63	3.00	35.9
73.5	0.00	0.00	0.00	8.47	0.00	0.00	0.00	0.00	0.00	0.00	8.47
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	9.84	4.38	5.84	21.2	11.3	16.3	7.76	7.01	8.67	8.50	100.0

Table 12b: Data for classification and size distributions of carbonate minerals with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 9. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (-37 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
.370E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.188	.217
2.30										
.467	0.00	.832E-01	0.00	0.00	0.00	0.00	0.00	0.00	1.04	1.53
3.25										
2.45	0.00	.125	0.00	0.00	0.00	0.00	0.00	0.00	1.88	4.45
4.64										
2.42	.346	.342	0.00	.517	0.00	.185	.254	0.00	1.77	5.84
6.50										
3.10	2.73	.896	1.63	0.00	0.00	0.00	0.00	0.00	3.28	11.4
9.19										
2.07	7.52	2.09	.698	0.00	0.00	0.00	0.00	.924	7.64	22.9
13.0										
0.00	4.44	8.10	0.00	4.82	0.00	1.99	0.00	0.00	2.88	21.4
18.4										
0.00	0.00	0.00	4.00	7.60	3.31	0.00	0.00	3.83	8.75	27.5
26.0										
0.00	0.00	0.00	6.62	0.00	0.00	0.00	0.00	0.00	0.00	6.62
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10.5	15.0	11.6	12.9	12.1	3.31	2.18	.254	4.75	27.2	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
.516E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.187	.239
1.62										
.555	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	1.83
2.38										
1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.80	5.04
3.25										
3.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.46	10.1
4.68										
3.78	.600	0.00	0.00	0.00	.858	0.00	0.00	0.00	6.72	12.0
6.50										
6.27	1.57	0.00	0.00	0.00	0.00	0.00	1.68	0.00	4.50	14.0
9.19										
1.90	2.19	2.52	0.00	0.00	0.00	0.00	2.19	0.00	11.4	20.2
13.0										
0.00	4.52	0.00	0.00	0.00	4.58	0.00	0.00	0.00	9.97	19.9
18.4										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.71	16.7
26.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.3	18.3	2.52	0.00	0.00	5.44	0.00	3.88	0.00	54.1	100.

Table 12c: Combined data from all screened samples. These data were used for classification of carbonate minerals with respect to pyrochlore plus columbite, and for plotting the histograms and 3D diagrams of Fig. 9.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	.845E-04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.306E-03	.391E-03
2.30	.158E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.547E-02	.705E-02
3.25	.104E-01	0.00	.151E-02	0.00	0.00	0.00	0.00	0.00	.253E-01	.372E-01
4.60	.851E-01	0.00	.227E-02	0.00	0.00	0.00	0.00	0.00	.449E-01	.132
6.50	.935E-01	.257E-01	.246E-01	0.00	.943E-02	.140E-02	.337E-02	.463E-02	0.00	.126	.288
9.19	.464	.739E-01	.548E-01	.675E-01	.148E-01	0.00	0.00	.276E-02	0.00	.304	.981
13.0	.846	.287	.220	.182	.160	.693E-01	.193E-01	.359E-02	.168E-01	.509	2.31
18.4	1.37	.649	.326	.104	.733E-01	.399E-01	.126	.598E-01	.222	1.10	4.00
26.0	1.51	.851	.727E-01	.316	.670	.555	0.00	.407	.281	1.46	6.12
36.8	1.42	1.66	.932	2.43	.528	1.10	.872	1.07	.717	1.30	12.0
52.0	.824	.886	3.64	1.80	2.18	1.68	1.13	.419	1.61	1.29	15.5
73.5	.314	1.40	2.43	5.17	.585	3.65	3.34	.899	2.78	4.41	25.2
104.	0.00	0.00	0.00	0.00	2.85	1.42	4.77	0.00	2.44	7.88	19.4
147.	0.00	0.00	0.00	0.00	0.00	2.11	5.48	0.00	0.00	2.07	9.66
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.35	0.00	0.00	4.35
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7.14	5.83	7.70	10.1	7.07	10.6	15.7	7.22	8.07	20.5	100.

Table 13a: Data for classification and size distributions of apatite with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 10. Top data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.0812-02	.2212-02
13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.0858-01	.0858-01
18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.343	.343
26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.797	.797
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	1.34
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.28	3.28
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.55	9.55
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.5	25.5
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.6	39.6
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.5	19.5
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.	100.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.480	.480
26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.47	2.47
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.55	5.55
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.3	16.3
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.8	28.8
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.4	21.4
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.0	25.0
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.0	100.0

Table 13b: Data for classification and size distributions of apatite with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 10. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (37 μm) sample.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.427E-01	.427E-01
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.217	.217
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.262	.262
6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.342	.342
9.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.214	.214
13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.420	.420
18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00
26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.6	21.6
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.8	25.8
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.2	37.2
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.0	12.0
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.0	100.0

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.193	.193
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.622	.622
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.534	.534
6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.748	.748
9.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.81	1.81
13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.35	2.35
26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.1	10.1
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.3	21.3
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	61.3	61.3
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.0	100.0

Table 13c: Combined data from all screened samples. These data were used for classification of apatite with respect to pyrochlore plus columbite and for plotting the histograms and 3D diagrams of Fig. 10.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.198E-02	.198E-02
2.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.920E-02	.920E-02
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.109E-01	.109E-01
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.103E-01	.103E-01
6.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.183E-01	.183E-01
9.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.839E-01	.839E-01
13.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.432	.432
18.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.85	1.85
26.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.91	2.91
36.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.51	6.51
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.3	12.3
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.9	23.9
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.0	36.0
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.9	15.9
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.0	100.0

Table 14a: Data for classification and size distributions of silicate minerals with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 11. Top data is for 65-100 mesh (208-147 μm) sample, and the bottom data is for the 100-200 mesh (147-74 μm) sample. The top row refers to classes, bottom-summary data for classes; left column sizes, right side=summary size data.

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	.346E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.346E-02
6.50	.692E-02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.552	.559
9.19	.277E-01	0.00	.121E-01	0.00	.225E-01	0.00	0.00	0.00	2.12	2.18
13.0	.429	.969E-01	0.00	0.00	.553E-01	0.00	0.00	0.00	6.06	6.64
18.4	.327	.273	0.00	.119	.847E-01	0.00	.847E-01	0.00	0.00	10.2	11.1
26.0	.896	.951E-01	.121	.171	0.00	0.00	0.00	.389	0.00	13.9	15.4
36.8	.557	.474	.192	0.00	0.00	0.00	0.00	0.00	.199	15.8	17.2
52.0	.512	.455	.481	2.02	0.00	0.00	0.00	.417	.433	17.0	19.2
73.5	0.00	0.00	.763	0.00	1.29	0.00	0.00	0.00	0.00	7.34	9.39
104.	0.00	0.00	0.00	0.00	1.51	0.00	0.00	0.00	0.00	9.25	10.8
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.63	7.63
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2.76	1.39	1.49	.291	2.96	0.00	.847E-01	.626	.638	69.6	100.0

	10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	
1.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6.50	.119	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.64	.64
9.19	.519	.166	0.00	0.00	0.00	0.00	0.00	0.00	4.56	4.63
13.0	.202	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.74	9.43
18.4	0.00	.737	0.00	0.00	.431	0.00	0.00	0.00	.301	11.6	13..
26.0	4.49	0.00	0.00	.851	0.00	0.00	0.00	0.00	.458	16.6	18.3
36.8	0.00	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.2	17.5
52.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.3	17.9
73.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.5	20.5
104.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5.33	4.55	0.00	.851	.431	0.00	0.00	0.00	.759	68.0	100.0

Table 14b: Data for classification and size distributions of silicate minerals with respect to pyrochlore plus columbite. These data were used to plot the histograms and 3D diagrams of Fig. 11. Top table is for 200-400 mesh (74-37 μm) sample, and the bottom table is for the -400 mesh (-37 μm) sample.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.62										
.194E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.61	1.63
2.30										
.139	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.92	6.06
3.25										
.365	0.00	0.00	0.00	0.00	.353E-01	0.00	0.00	0.00	13.0	13.4
4.60										
.477	.688E-01	.102	0.00	0.00	0.00	.688E-01	0.00	0.00	13.6	14.4
6.50										
.286	.212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.8	14.7
9.19										
.972	0.00	.357	.289	.364	0.00	0.00	0.00	0.00	11.3	13.3
13.0										
0.00	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.1	13.4
18.4										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	33.3	33.3
26.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.18	1.58	.459	.289	.364	.353E-01	.688E-01	0.00	0.00	35.0	100.0

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.26	1.26
1.62										
.103	.639E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.06	5.18
2.30										
.524E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.7	12.8
3.25										
.103	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.1	13.2
4.60										
0.00	0.00	.100	0.00	0.00	0.00	0.00	0.00	0.00	13.6	13.9
6.50										
.422	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.2	13.6
9.19										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.1	14.1
13.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.55	4.55
18.4										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.05	9.05
26.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.46	6.46
36.8										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
52.0										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73.5										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.68	.103E-01	.100	0.00	0.00	0.00	0.00	0.00	0.00	9.2	100.0

Table 14c: Combined data from all screened samples. These data were used for classification of silicate minerals with respect to pyrochlore plus columbite, and for plotting the histograms and 3D diagrams of Fig. 11.

10.00	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0		
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.293E-01	.293E-01
1.62										
.487E-02	.392E-03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.322	.328
2.30										
.198E-01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	1.07
3.25										
.510E-01	0.00	0.00	0.00	0.00	.451E-02	0.00	0.00	0.00	2.56	2.61
4.60										
.992E-01	.879E-02	.159E-01	0.00	0.00	0.00	.879E-02	0.00	0.00	3.75	3.89
6.50										
.201	.750E-01	.679E-02	0.00	.126E-01	0.00	0.00	0.00	0.00	5.83	6.13
9.19										
.423	.543E-01	.455E-01	.378E-01	.774E-01	0.00	0.00	0.00	.869E-01	8.45	9.17
13.0										
.183	.531	0.00	.669E-01	.172	0.00	.475E-01	0.00	.144	12.2	13.3
18.4										
1.80	.533E-01	.679E-01	.342	0.00	0.00	0.00	.117	0.00	14.5	16.9
26.0										
.312	1.32	.108	0.00	0.00	0.00	0.00	0.00	.111	12.5	14.4
36.8										
.287	.255	.225	0.00	0.00	0.00	0.00	.234	.246	15.4	16.7
52.0										
0.00	0.00	.427	0.00	.722	0.00	0.00	0.00	0.00	4.11	5.26
73.5										
0.00	0.00	0.00	0.00	.847	0.00	0.00	0.00	0.00	5.18	6.03
104.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.28	4.28
147.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
208.										
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.38	2.29	.896	.445	1.83	.451E-02	.563E-01	.351	.588	90.2	100.0